Appendix E. Pre-Construction Technical Report

FINAL REPORT

Wildlife Baseline Studies for the Glenrock Wind Resource Area Converse County, Wyoming

April 18th, 2007 – November 14th, 2007

Prepared for:

CH2M Hill
9193 South Jamaica Street
Englewood, CO 80112

Prepared by:

Greg Johnson, Kimberly Bay, Jamie Eddie and Troy Rintz

Western **E**co**S**ystems **T**echnology**,** Inc.
2003 Central Avenue
Cheyenne, WY 82001

WEST, Inc.

February 21, 2008

EXECUTIVE SUMMARY

PacifiCorp has proposed a wind-energy facility in Converse County, Wyoming, near the town of Glenrock. CH2M Hill contracted Western Ecosystems Technology, Inc. to conduct surveys and monitoring of wildlife resources in the proposed Glenrock Wind Resource Area for the purpose of estimating impacts of project construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the study area by birds, and in particular, raptors; 2) locate raptor nests; 3) estimate the seasonal and spatial use of the study area by bats; 4) describe the occurrence of any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife; 5) estimate the seasonal use and distribution of greater sage-grouse within the study area and a reference area; 6) describe incidental observations of wildlife; 7) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind energy facility; and 8) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

The objective of the fixed point bird use surveys was to estimate the seasonal, spatial, and temporal use of the Glenrock Wind Resource Area by birds, and in particular, raptors. Surveys were conducted at 12 points located within the study area approximately once each week during the spring season (April 18 – June 9, 2007) and the fall season (September 19 – November 14, 2007). A total of 186 twenty-minute fixed point bird use surveys were conducted during the study, and 26 bird species were observed during the fixed point surveys.

To standardize the data for comparison between points, seasons, and with other wind-energy facilities, bird use, frequency of occurrence, and species composition were calculated from observations within an approximate half mile (800 meter) radius of the point. Bird use by species was calculated as the mean number of birds per 20-minute survey. Overall, passerines were the most abundant bird type observed in the spring (6.77 birds/plot/20-min survey), followed by raptors (1.09), and upland gamebirds (0.12). In the fall, the most abundant bird type observed was again passerines (2.87 birds/plot/20-min survey), followed by raptors (1.08), and doves/pigeons (0.22).

During the study, 511 single birds or groups totaling 1,194 individuals were observed flying during fixed point bird use surveys. For all species combined, 69.7 % of all flying birds observed were below the likely zone of risk for turbine collision, 24.0 % were within the zone of risk, and 6.3 % of birds were observed flying above the zone of risk of typical turbines that could be used in the Glenrock Wind Resource Area. Bird types most often observed flying within the turbine zone of risk were raptors (33.9%) and passerines (22.2%). For species with at least 15 separate observations of flying birds, those most often observed within the zone of risk were golden eagle (44.9 %), horned lark (2.4%), northern harrier (21.3%), and red-tailed hawk (15.8 %). Based on the use (measure of abundance) of the site by each species and the flight characteristics observed for that species, American crow had the highest probability of turbine exposure. The only raptor species with a relatively high exposure index was golden eagle, which ranked second of all species.

For all bird species combined, use was highest at point nine, primarily due to high passerine use. Points four, five, and six had elevated use compared to other points, also primarily due to high numbers of passerines, as well as raptors. Point three also had somewhat higher use than the remaining points, due mostly to greater sage-grouse. No obvious flyways or concentration areas were observed and there were no strong associations with topographic features within the study area for raptors or other large birds.

Based on fixed point bird use data collected for the Glenrock Wind Resource Area, mean annual raptor use was 1.09 birds/20-minute survey. Raptor use in the study area was moderate, relative to data collected at existing and proposed wind-energy facilities around the country using similar protocols. A regression analysis of raptor use and raptor collision mortality for 11 new-generation wind-energy facilities, where similar methods were used to obtain raptor use estimates, showed a significant correlation (R^2 = 81.4 %) between raptor use and raptor collision mortality. Using this regression to predict raptor collision mortality at the Glenrock Wind Resource Area yields an estimated fatality rate of 0.14/MW/year, or 14 raptors per year for a 100-MW wind-energy facility.

Eight raptor nests were found during a raptor nest survey of the project area and one mile buffer, three of which were golden eagle nests on artificial nesting platforms that lie within the Glenrock Wind Resource Area boundaries. Another golden eagle nest was located in a cottonwood tree just northeast of the project area boundary. Other active nests included those of ferruginous hawk, short-eared owl, and red-tailed hawk. An inactive ferruginous hawk nest was also found.

Although construction and operation of the wind-energy facility may displace some groups of birds, the Glenrock Wind Resource Area will be sited in previously altered habitat (a reclaimed coal mine), and undisturbed native habitats are abundant in the region. Therefore, it is unlikely that displacement of birds would result in any population impacts.

Three adult males, six adult females, and 19 juvenile sage-grouse were classified during sage-grouse brood surveys. Based on results of these surveys, use of the project area by sage-grouse broods is relatively low and the project area does not likely provide important brood rearing habitat. Thirty-five greater sage-grouse pellet groups were found at the 114 turbine plots sampled, resulting in a density of 99.0 pellet groups/acre. At the 114 reference plots, six greater sage-grouse pellet groups were found, resulting in a density of 17.0 pellet groups/acre. These pre-construction data will provide the basis for assessing potential displacement of greater sage-grouse following completion of the wind-energy facility.

Based on data collected during the early summer breeding season, raptor use of the Glenrock project area is relatively high compared to most other wind resource areas in the US, but total avian use is lower than that observed at most of the other wind resource areas evaluated throughout the US. Therefore, mortality of non-raptor avian species will likely be low compared to many other wind resource areas in the US. Golden eagles comprised nearly half (47%) of all raptors observed on site. High use by golden eagles was likely due to the presence of three active nests on artificial platforms within the Glenrock Wind Resource Area. A permit to move these nests structures has been obtained from the US Fish and Wildlife Service, and all golden eagle nest structures will be moved from the wind resource area prior to constructing turbines. Use of the project area by golden eagles will likely be reduced substantially once these nests are no longer present.

The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the study area by bats. Two AnaBat™ II echolocation detectors were used to periodically monitor bat use at the study during the period August 3 - October 16, 2007. A total of 41 bat calls were recorded during 142 bat detector nights. Most (85 %) of the calls were < 35 kHz in frequency (<e.g., big brown bat, hoary bat), and the remaining calls were > 35 kHz (e.g., mouse-eared bats (*Myotis* spp.)). The mean number of bat calls recorded per night per detector was higher for the Anabat unit placed in the north of the study area (0.41 calls/night) than for the southern unit (0.18). Peak activity levels for bat calls were in September, corresponding to the fall bat migration period. It is likely some bats migrate through the Glenrock Wind Resource Area.

The bat use data indicated much lower bat activity compared to other wind projects in Wyoming, including the nearby Foote Creek Rim Windpower Project, which estimated 1.34 bat fatalities/MW/year. Bat mortality at the Glenrock Wind Resource Area would likely be lower than that documented at Foote Creek Rim. Furthermore, we expect bat mortality at the Glenrock Wind Resource Area to be much lower than the mortality rate at wind-energy facilities in the eastern US, where activity levels and associated reported fatalities are much higher.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

PacifiCorp has proposed a wind-energy facility in Converse County, Wyoming, near the town of Glenrock. CH2M Hill contracted Western Ecosystems Technology, Inc. (WEST), to conduct surveys and monitoring of wildlife resources in the proposed Glenrock Wind Resource Area (GWRA) for the purpose of estimating impacts of project construction and operations on wildlife.

The principal objectives of this wildlife monitoring study were to: 1) estimate the seasonal, spatial, and temporal use of the study area by birds, and in particular, raptors; 2) locate raptor nests, particularly those of golden eagles; 3) estimate the seasonal and spatial use of the study area by bats; 4) describe the occurrence of any federal and state threatened, endangered, proposed, candidate, or sensitive-status wildlife; 5) estimate the seasonal use and distribution of greater sage-grouse (*Centrocercus urophasianus*) and broods within the study area and a reference area; 6) describe incidental observations of wildlife; 7) estimate any potential impacts to birds and bats that could result from construction and operation of the proposed wind energy facility; and 8) identify potential project modifications and/or mitigation measures that could reduce negative impacts.

This report provides results of the baseline surveys at the GWRA conducted in 2007. Baseline surveys conducted at the GWRA included fixed point bird use surveys; raptor nest surveys; bat acoustic surveys; federal and state threatened, endangered, proposed, candidate, or sensitive status wildlife surveys; greater sage-grouse brood and pellet count surveys; and incidental wildlife observations. In addition to site-specific data, this report presents existing information and results of studies conducted at other wind-energy facilities, as our ability to estimate potential bird and bat mortality at the proposed GWRA is greatly enhanced by operational monitoring data collected at existing wind-energy facilities. For several wind-energy facilities, standardized data on fixed point bird use surveys and bat acoustics surveys were collected in association with standardized post-construction (operational) monitoring, allowing comparisons of bird/bat use with bird/bat mortality.

STUDY AREA

The proposed GWRA is located in west-central Converse County, north of the town of Glenrock, Wyoming (Figure 1). The study area includes the proposed wind power development site and an adjacent one-mile (mi) buffer. The elevation of the GWRA ranges from approximately 5,700 to 5,900 feet (ft; 1,730 to 1,800 meters (m)) above sea-level. The GWRA was formerly an open pit coal mine, and the dominant habitat is reclaimed grassland with some big sagebrush (*Artemisia tridentata*). Land ownership is private.

The GWRA is proposed to consist of up to 66 wind turbines, with a capacity of approximately 100 MW. The most likely turbine size is 1.5 MW with a rotor diameter of 252 ft (77 m). The wind turbines will be situated on 262-ft (80-m) tall steel tubular towers secured to concrete foundations.

METHODS

The baseline study conducted at the GWRA in 2007 consisted of the following components: 1) fixed point bird use surveys; 2) raptor nest surveys; 3) bat acoustic surveys; 4) greater sage-grouse brood and pellet count surveys; and 5) incidental wildlife observations.

Fixed Point Bird Use Surveys

The objective of the fixed point bird use surveys was to estimate the seasonal, spatial, and temporal use of the study area by birds, and in particular raptors. Fixed point surveys (variable circular plots) were conducted using methods described by Reynolds et al. (1980). The points were selected to survey representative habitats and topography of the study area while also providing relatively even coverage with minimal overlap of points. All birds seen during fixed point surveys were recorded. Raptors and other large birds, species of concern, and species not previously seen in the study area that were observed between fixed point surveys were recorded. Coordinates derived from Global Positioning System satellites (GPS) were also noted for species of concern.

Bird Use Survey Plots

Twelve points were selected to achieve optimal coverage of the study area and habitats within the study area (Figure 2). Each survey plot was an approximate half-mile (800-m) radius circle centered on a point. All species of birds observed during fixed point surveys were recorded, and all large birds observed perched within or flying over the plot were recorded and mapped. Small birds (e.g., sparrows) within 328 ft (100 m) of the point were recorded, but not mapped. Observations of birds beyond the plot were recorded, but were not included in the statistical analyses. A unique observation number was assigned to each observation.

The date, start and end time of each 20-minute (min) survey period, and weather information such as temperature, wind speed, wind direction, and cloud cover were recorded for each survey. Species or best possible identification, number of individuals, sex and age class (if possible), distance from plot center when first observed, closest distance, altitude above ground, activity (behavior), and habitat(s) were recorded for each observation. The behavior of each bird observed and the vegetation type in which, or over which, the bird occurred were recorded based on the point of first observation. Approximate flight height and flight direction at first observation were recorded to the nearest 15-ft (five-m) interval.

Locations of raptors, other large birds, and species of concern seen during the fixed point bird use surveys were recorded on field maps by observation number. Any comments or unusual observations were recorded in the comments section of the data sheet.

Observation Schedule

Sampling intensity was designed to document bird use and behavior by habitat and season within the study area. Surveys were conducted approximately weekly during the spring migration and early breeding season (April 18 to June 9, 2007) and weekly during the fall season (September 19 to November 14, 2007). Surveys were conducted during daylight hours and survey periods were varied to approximately cover all daylight hours during a season.

Raptor Nest Surveys

The entire GWRA, as well as a one-mi buffer around the study area, was searched for active and non-active raptor nests. Several golden eagle (*Aquila chrysaetos*) artificial nesting platforms had previously been constructed on the GWRA to mitigate impacts to nesting eagles from the former coal mine. These platforms were examined, and the GWRA was also systematically searched by vehicle and by foot to locate nests on natural substrates. Trees, cliffs, rock outcrops and other potential nest structures, such as wind mills and utility poles, were investigated. Universal Transverse Mercator (UTM) coordinates, as well as nesting substrate and current status (inactive, active, incubating, young in nest), were recorded for each nest located.

Greater Sage-Grouse Brood Surveys

No sage-grouse leks are known to occur on or near the project area; however, the area is used as brood rearing habitat. Therefore, four sage-grouse brood surveys were conducted in July and August 2007, to determine if important sage-grouse brood rearing habitat is present in the project area. Due to concerns with vehicles starting fires, brood surveys were conducted from an all terrain vehicle (ATV) and by foot. The entire project area was surveyed in the early morning or late evening. All sage-grouse observed were classified (adult male, adult female, chick) and a GPS coordinate was obtained. Dogs were used during one survey to assist in the search and to help obtain accurate counts of chicks. Results from this study may be used to assist with siting turbines to avoid important sage-grouse habitats. In addition, there is little data on actual response of sage-grouse to wind turbines. The data collected during this study would provide important baseline data on sage-grouse use of the project area. Similar data could be collected after the GWRA is developed to determine how sage-grouse respond to wind-energy facility development.

Greater Sage-Grouse Pellet Count Surveys

The purpose of the greater sage-grouse pellet count survey was to obtain pre-construction data on use of the GWRA by greater sage-grouse by estimating pellet density. Similar data collected after construction will allow us to determine if construction of and operation of the GWRA results in avoidance of the wind-energy facility. To ensure any measured changes in use of the GWRA following construction are not due to other factors, such as weather, greater sage-grouse pellet count surveys were also implemented on a reference area located over one mi (1.61 kilometers (km)) from the nearest proposed turbine location.

Six plots were established at 19 proposed turbine locations within the sage brush habitat potentially used by greater sage-grouse (Figure 3), resulting in a total of 114 plots for pellet counts. The six plots were established at random distances from 32.81 to 262.47 ft (10 to 80 m) away from each proposed turbine, and perpendicular to the access road. Each plot was marked with a 12-inch (0.31-m) piece of rebar, and the GPS location was recorded. All greater sage-grouse pellet groups within a 6.56-ft (2-m) radius of each point were counted and removed from the plot. The survey was conducted in the fall (November 12-13, 2007). Because this was the first survey, the primary purpose was to clear plots of all pellets. However, the number of greater sage-grouse pellet groups within each plot which were estimated to be less than six months old were recorded to gain some insight into the previous summer's use. Only pellet groups with over half of the pellet group on the horizontal surface within the plot were counted. For those pellet groups that were half in and half out, every other pellet was counted (Neff 1968).

For reference data, six plots were established at 19 random points located in an area of similar topography and vegetation as the turbines, but at least one mi (1.61 km) from the nearest turbine (Figure 3). Methods were identical to those at the turbine plots.

Acoustic Bat Surveys

The objective of the acoustic bat surveys was to estimate the seasonal and spatial use of the GWRA by bats. Bats were surveyed using AnaBat™ II (Anabat) ultrasonic detectors coupled with Zero Crossing Analysis Interface Modules (ZCAIM; Titley Electronics Pty Ltd., NSW, Australia). Bat detectors are widely used to index and compare habitat use by bats. The use of bat detectors for calculating an index to bat impacts has been used at several wind-energy facilities, and is a primary and economically feasible bat risk assessment tool (Arnett 2007). Bat activity was surveyed using two detectors, each placed at a single fixed location (Figure 4) from August 3, 2007 to October 16, 2007, a period corresponding to likely fall bat migration at this site.

Anabat detectors record bat echolocation calls with a broadband microphone. The echolocation sounds are then translated into frequencies audible to humans by dividing the frequencies by a predetermined ratio. A division ratio of eight was used for the study. Bat echolocation detectors also detect other ultrasonic sounds made by insects, raindrops hitting vegetation, and other sources. A sensitivity level of six was used to reduce interference from these other sources of ultrasonic noise. The calls were recorded via the ZCAIM, which uses a Compact Flash memory card with large storage capacity. The Anabat detectors were placed inside plastic weather-tight containers with a hole cut in the side of the container for the microphone to extend through. Microphones were encased in PVC tubing with drain holes that curved vertically outside the container to minimize the potential for water damage due to rain. The Anabat units were elevated approximately 3 ft (1 m) above ground to minimize echo interference and elevate the unit above vegetation, and programmed to turn on an approximately one half-hour before sunset and turn off approximately one half-hour after sunrise.

Incidental Wildlife Observations

The objective of the incidental wildlife observations was to provide use and occurrence information about wildlife occurring outside of the standardized survey areas, which may be affected by the proposed wind-energy facility. Incidental wildlife observations were made while observers were within the study area conducting various surveys. All sightings of raptors, raptor nests, unusual or unique birds, sensitive species, mammals, reptiles, and amphibians were recorded. These observations were recorded in a similar fashion to those recorded during the standardized surveys. The observation number, date, time, species, number of individuals, sex/age class, distance from observer, activity, height above ground (for bird species), habitat, and, in addition, the GPS location of sensitive species was recorded.

Statistical Analysis

Quality Assurance and Quality Control
Quality assurance and quality control (QA/QC) measures were implemented at all stages of the study, including in the field, during data entry and analysis, and report writing. Following field surveys, observers were responsible for inspecting their data forms for completeness, accuracy, and legibility. A sample of records from an electronic database was compared to the raw data forms and any errors detected were corrected. Irregular codes or data suspected as questionable were discussed with the observer and/or project manager. Errors, omissions, or problems identified in later stages of analysis were traced back to the raw data forms, and appropriate changes in all steps were made.

Data Compilation and Storage
A Microsoft® ACCESS database was developed to store, organize and retrieve survey data. Data from data forms were keyed into the electronic database using a pre-defined format to facilitate subsequent QA/QC and data analysis. All data forms, field notebooks, and electronic data files were retained for reference.

Fixed Point Bird Use Surveys
<u>Bird Diversity and Species Richness</u>
A list of all bird species observed during all surveys types was generated for the GWRA. The total number of unique species and the mean number of species observed per survey (i.e., number of species/plot/20-min survey) were calculated to illustrate and compare differences between seasons for fixed point bird use surveys.

<u>Bird Use, Composition, and Frequency of Occurrence</u>
Species lists, with the number of observations and the number of groups, were generated by season, including all observations of birds detected regardless of their distance from the observer. For the standardized fixed point bird use estimates, only observations of birds detected within the half-mile (800-m) radius plot were used. Estimates of bird use (i.e., number of birds/plot/20-min survey) were used to compare differences between bird types, seasons, and other wind-energy facilities.

The frequency of occurrence by species was calculated as the percent of surveys in which a particular species was observed. Frequency of occurrence provides relative estimates of the bird diversity of the study area. For example, a particular species may have high use estimates for the study area based on just a few observations of large flocks; however, the frequency of occurrence would indicate that it only occurred during a few of the surveys therefore making it less likely to be affected by the wind-energy facility.

<u>Bird Flight Height and Behavior</u>
To calculate potential risk to bird species, the first flight height recorded was used to estimate the percentages of birds flying within the "likely zone of risk" for turbines that could potentially be used at the GWRA. The likely zone of risk is defined as a flight height of 82 to 410 ft (25 to 125 m), which is the height of turbine blades of typical turbines that could be used at the GWRA.

<u>Bird Exposure Index</u>
A relative index to collision exposure (R) was calculated for bird species observed during the fixed point bird use surveys using the following formula:

$$R = A*P_f*P_t$$

Where A = mean relative use for species *i* (observations within a half-mile (800 m) of observer) averaged across all surveys, P_f = proportion of all observations of species *i* where activity was recorded as flying (an index to the approximate percentage of time species *i* spends flying during the daylight period), and P_t = proportion of all initial flight height observations of species *i* within the likely zone of risk. This index does not account for differences in behavior other than flight heights and percent of birds observed flying.

<u>Spatial Use</u>
The objective of mapping observed bird locations and flight paths was to look for areas of concentrated use by raptors and other large birds, and/or consistent flight patterns within the study area. Data were analyzed by comparing use among survey stations and association to topographic features. This information may be used to aid in turbine layout design or adjustments of individual turbines by micro-siting.

Acoustical Bat Surveys
The units of activity were number of bat passes (Hayes 1997). The absolute abundance of bats within a study area cannot be determined through acoustic sampling, and bat pass data represent levels of bat activity rather than numbers of individuals. A pass was defined as a continuous series of ≥ two call notes produced by an individual bat with no pauses between call notes of > one second (White and Gehrt 2001, Gannon et al. 2003). In this report, the terms bat pass and bat call are used interchangeably. The number of bat passes was determined by downloading the data files to a computer and tallying the number of echolocation passes recorded. Total number of passes was corrected for effort by dividing by the number of detector nights. Bat passes were classified as either high-frequency calls (≥ 35 kHz), which are generally given by small bats (e.g. *Myotis* spp.), or low-frequency (< 35 kHz), which are generally given by larger bats (e.g. silver-haired bat (*Lasionycteris noctivagans*), big brown bat (*Eptesicus fuscus*), Townsend's big-eared bat (*Corynorhinus townsendii*), and hoary bat (*Lasiurus cinereus*)). Data determined to be noise (produced by a source other than a bat), or call notes that did not meet the pre-specified criteria to be termed a pass, were removed from the analysis. To establish which species may have produced the high- and low-frequency calls recorded, a list of species expected to occur in the study area was compiled from range maps (Harvey et al. 1999, BCI website).

The total number of bat passes per detector night was used as an index for bat use in the GWRA. Bat pass data represent levels of bat activity, rather than the numbers of individuals present, because individuals cannot be differentiated by their calls. To predict potential for bat mortality (i.e. low, moderate, high), the mean number of bat passes per detector night across locations (i.e., the mean of ratios) was compared to existing data from wind-energy facilities where both bat activity and mortality levels have been measured.

RESULTS

Fixed Point Bird Use Surveys

Fixed point bird use surveys were conducted approximately once weekly during the spring (April 18 – June 9, 2007) and the fall (September 19 – November 14, 2007) at the GWRA. A total of 186 twenty -minute fixed point surveys were conducted (Table 1).

Bird Diversity and Species Richness
Twenty-six unique species were observed over the course of all fixed point bird use surveys, with the mean number of species observed per survey being 2.01 (Table 1).

Bird Use by Species
A total of 1,194 individual bird observations within 511 separate groups were recorded during the fixed point bird use surveys (Table 2). Cumulatively, three species (11.5% of all species) comprised approximately 67.1% of all observations: horned lark (*Eremophilia alpestris*; 48.3%), western meadowlark (*Sturnella neglecta*; 10.6%), and golden eagle (8.1%). All other species comprised less than 4.0% of the observations individually.

Mean bird use estimates (number of birds/plot/20-min survey using detections within a half mile (800 m) of each point) were calculated by species and season (Table 3). The raptor species with the highest overall use was golden eagle (0.47 birds/plot/20-min survey in the spring, and 0.51 in the fall) and northern harrier (0.38 bird/plot/20-min survey in the spring and 0.18 in fall) (Table 3). All raptor species comprised less than five percent of the use estimate for both the spring and fall seasons. During the spring, western meadowlark had the highest use (1.36), followed by horned lark (0.42), and lark bunting (*Calamospiza melanocorys*; 0.28). During the fall, horned lark had the highest use (5.05), followed by American crow (*Corvus brachyrhynchos*; 1.17), and western meadowlark (0.20).

Frequency of Occurrence by Species
The frequency of occurrence by species was calculated as the percent of surveys in which a particular species was observed. Frequency of occurrence provided relative estimates of the bird diversity in the study area (Table 3). During the spring, only western meadowlarks were observed at more than 50% of the surveys (80.5%), with the next highest frequency being golden eagle (36.2%). During the fall, only horned larks were observed during more than 50% of the surveys (55.6%); all other species were observed at lower levels, with the next highest frequency being for golden eagle (33.3%).

Bird Use by Season and Type
Higher overall bird use occurred in the fall (7.98 birds/plot/20-min survey) compared to the spring (4.18; Table 3). The higher use in the fall was in part due to large numbers of horned larks and American crows, which were not as abundant in the spring.

<u>Shorebirds</u>
Shorebirds had the lowest abundance in the spring (0.1 birds/plot/20-min survey), and were not present in the fall (Table 3). Only killdeer (*Charadrius vociferous*) represented this bird type, and

only one individual was seen in the spring (Table 2). This species was observed on 1.4% of the spring surveys.

Raptors

Raptors were the second most abundant bird type in the spring (1.08 birds/plot/20-min survey; Table 3) and fall (1.09), following only passerines (2.87 in the spring, 6.77 in the fall). The golden eagle was the most abundant raptor species in both the spring and fall (0.47 and 0.51, respectively). Raptors were observed more often in the spring (61.2%) compared to fall (59.3%).

Upland Gamebirds

Upland gamebirds were the third most abundant type in the fall (0.12 birds/plot/20-min survey; Table 3), and were not seen in the spring. Upland gamebirds consisted solely of greater sage-grouse. This species was observed on 0.9% of the fall surveys.

Doves/pigeons

Doves/pigeons had the second lowest abundance in the spring (0.22 birds/plot/20-min survey) and were not present in the fall (Table 3). Only mourning dove (*Zenaida macroura*) represented this bird type, and only 18 individuals were seen in the spring (Table 2). This species was observed on 6.2% of the spring surveys.

Passerines

Passerines were the most abundant bird type in the spring (2.87 birds/plot/20-min survey 68.6% of the composition; Table 3) and the fall (6.77 birds/plot/20-min survey; 84.8%). The higher use in the spring was in part due to western meadowlark, which made up 32.6% of the bird use in this season. Passerines were observed less often in the spring (63.9%) compared to surveys in the fall (89.3%). The higher use in the fall was in part due to 27 large groups of horned lark that made up 63.2% of the bird use in this season, and due to four large groups of American crow, comprising 126 individuals, that made up 14.6%.

Bird Flight Height and Behavior

Flight height characteristics were estimated for both individual bird species and bird types (Tables 4 and 5). Percentages of observations below, within, and above the rotor swept height of 82 to 410 ft (25 to 125 m) above ground level (AGL), the zone of risk (ZOR) for collision, were reported.

Five species had at least 15 groups observed flying, but none of these species were observed flying within the ZOR for more than 50% of the observations (Table 5). Two species, American crow and killdeer, were always observed within the ZOR, but only had a small number of groups (one to four observations; Table 5).

Overall, 24.0% of the birds observed flying were recorded within the ZOR, 69.7% were below the ZOR, and 6.3% were flying above the ZOR (Table 4). Approximately one-third (34.4%) of flying raptor observations were of individuals below the ZOR, 33.9% were within the ZOR, and 31.7% were of individuals above the ZOR.

Raptor subgroups with the highest percentage of observations within the ZOR were eagles (44.9 %) and falcons (40.0%). The majority of flying buteos were observed above the ZOR (52.4%), but the majority of all other bird types and subgroups were within or below the ZOR. Shorebirds, upland gamebirds, doves/pigeons, and passerines were typically observed flying below the ZOR.

Bird Exposure Index
A relative exposure index (bird use multiplied by the proportion of flying observations within the ZOR) was calculated for each species (Table 5). This index is only based on initial flight height observations and relative abundance, and does not account for other possible collision risk factors such as foraging or courtship behavior (Kerlinger and Dowdell 2003). No species of bird had exposure indices higher than 1.00; the highest was American crow, at 0.66.

Spatial Use
Mean use (birds/20-min survey) was plotted by point for all birds combined, shorebirds, raptors, upland gamebirds, doves/pigeons, and passerines (Figures 5a-g). For all bird species combined, use was highest at point nine (8.50 birds/20-min survey), primarily due to high passerine use (8.06). Points four, five, and six had slightly higher use (7.56, 8.00, and 7.56, respectively) compared to other points, also primarily due to high numbers of passerines and raptors. Bird use for the other points ranged from 4.27 to 8.00 birds/20-min survey. The highest raptor use (1.38-1.94 birds/20-min survey) occurred at points one, three, four, and five, which are all located in the northern portion of the project area (Figure 5). The available data indicate that turbine development at the northern end of the project area would pose the greatest risk to raptors. No other obvious flyways or concentration areas were observed.

Shorebirds were only observed at point 11, and had the lowest use (0.06). Greater sage-grouse were only observed at point three and had a comparatively low use (0.93). Doves/pigeons were observed only at points six and nine (1.00 and 0.13, respectively). The high mean use estimate for point one is primarily due to high passerine use (8.06) at this point. Passerine use at all other points, excluding point nine, ranged from 3.27 to 6.63, making passerines the bird type with the highest use for all points collectively.

Raptor Nest Surveys

Eight raptor nests were found during the raptor nest surveys. Three of the artificial nesting platforms that lie within the GWRA boundaries had active golden eagle nests in 2007. Another active golden eagle nest was located in a cottonwood tree just northeast of the project area boundary (Figure 6). One active ferruginous hawk nest (*Buteo regalis*) and one active short-eared owl (*Asio flammeus*) nest were located on the ground in the GWRA. A red-tailed hawk (*Buteo jamaicensis*) nest was active earlier in the spring, but was not active on June 9, 2007 and was apparently not successful. One inactive ferruginous hawk nest was also located (Figure 6).

Greater Sage-Grouse Brood Surveys

Three adult males, six adult females, and 19 juvenile sage-grouse were classified during the sage-grouse brood surveys (Table 6; Figure 7). Based on results of these surveys, use of the project area by sage-grouse broods is relatively low, and the project area does not likely provide important brood rearing habitat.

Greater Sage-Grouse Pellet Count Surveys

Thirty-five greater sage-grouse pellet groups were found at the 114 turbine plots, resulting in a density of 99.0 pellet groups/acre. At the 114 reference plots, six greater sage-grouse pellet groups were found, resulting in a density of 17.0 pellet groups/acre. These pre-construction data will provide the basis for assessing potential displacement of greater sage-grouse following completion of the wind-energy facility.

Bat Acoustic Surveys

Bat activity was monitored at two sampling locations on a total of 75 nights during the period August 3 – October 16, 2007. Anabat units were operable for 95% of the sampling period, or an average of 71 nights, for a total of 142 detector-nights. Forty-one bat passes were detected over the 142 detector-nights (Table 7). Averaging bat passes per detector-night across locations, we detected a mean of 0.27 bat passes per detector-night. Most of this activity was recorded in September.

Spatial Variation
We detected twice as much bat activity at the northern location (point two; mean = 0.41 bat passes per detector-night) as we did at the southern location (point one; mean = 0.18; Figure 8a). The northern location also recorded most of the activity observed during September (Figure 8b). At both locations, low-frequency (LF) bat passes were much more numerous than high-frequency (HF) bat passes.

Seasonal Variation
Bat activity was extremely low during August, increasing slightly in September, and decreasing again in October (Figures 9a-b). Relatively high noise levels recorded August 3 – 12 may have interfered with detection of bats during this time period, when no bats were recorded (Figure 10). LF bat activity comprised 85% of the total passes, and was highest during September; HF bat activity was extremely low during the study, and completely absent during September (Figure 9b). The greatest bat activity occurred between September 20 – 22 (Figure 10), when a combined 12 bat passes (30% of all passes) were recorded, all of which were from LF bats.

Species Composition
Species identification for specific passes was only possible for the hoary bat; therefore, passes by this species could be separated from passes by other low-frequency bats. We detected two hoary bat passes (5% of all calls); one at the southern location on September 21, and the other at the northern location on September 28, 2007.

Sensitive Species Observations

No federally listed species were observed while conducting the spring and early summer surveys. The Wyoming Game and Fish Department does not maintain a list of state-threatened, endangered, or sensitive species. However, the Casper Field Office of the Bureau of Land Management does maintain a list of sensitive species for that area. Based on this list, four sensitive bird species were observed, including ferruginous hawk, greater sage-grouse, sage thrasher (*Oreoscoptes montanus*), and Brewer's sparrow (*Spizella breweri*). Fourteen ferruginous hawks were observed during fixed point bird use surveys, and two nests were found in the project area during raptor nest surveys. Two groups totaling 13 greater sage-grouse were observed during fall fixed point surveys, and several were observed during focused brood surveys (see above). Sage thrashers appear to be relatively uncommon in the project area, as only 12 were observed during 186 point count surveys. Brewer's sparrow appear to be relatively rare, as only three were observed during the spring study.

DISCUSSION AND IMPACT ASSESSMENT

Bird Impacts

Direct Effects

The most probable impact to birds resulting from wind projects is direct mortality, or injury due to collisions with turbines or guy wires of meteorological towers (met towers). Collisions may occur with resident birds foraging and flying within the project area, or with migrant birds seasonally moving through the project area. Project construction could affect birds through loss of habitat, potential fatalities from construction equipment, and disturbance/displacement effects from construction activities. Impacts from the decommissioning of the facility are anticipated to be similar to construction in terms of noise, disturbance and equipment. Potential mortality from construction equipment is expected to be very low. Equipment used in wind-energy facility construction generally moves at slow rates or is stationary for long periods (e.g., cranes). The risk of direct mortality from construction to birds is most likely potential destruction of a nest for ground- and shrub-nesting species during initial site clearing.

Substantial data on bird mortality at wind-energy facilities are available from studies in California and throughout the west and Midwest. Of 841 bird fatalities reported from California studies (>70% from Altamont Pass, CA), 39% were diurnal raptors, 19% were passerines (excluding house sparrows and European starlings), and 12% were owls. Non-protected birds including house sparrows, European starlings, and rock doves comprised 15% of the fatalities. Other bird types generally made up <10% of the fatalities (Erickson et al. 2002). During 12 fatality monitoring studies conducted outside of California, diurnal raptor fatalities comprised only 2% of the wind project-related fatalities and raptor mortality averaged 0.03/turbine/year. Passerines (excluding house sparrows and European starlings) were the most common collision victims, comprising 82% of the 225 fatalities documented. These wind-energy facilities that were studied outside California have more modern turbines than the older California wind-energy facilities.

For all bird species combined, estimates of the number of bird fatalities per turbine per year from individual studies have ranged from 0 at the Searsburg, Vermont (Kerlinger 1997) and Algona, Iowa sites (Demastes and Trainer 2000), to 7.7 at the Buffalo Mountain, Tennessee site (Nicholson 2003). Using mortality data from the last 10 years from wind projects throughout the entire US, the average number of bird collision fatalities is 3.1 per megawatt per year, or 2.3 per turbine per year (NWCC 2004).

Raptor Use and Exposure Risk

Mean raptor use at the GWRA was compared with other wind-energy facilities. Spring and fall values (1.09 birds/20-min and 1.08, respectively) from the GWRA were compared separately to raptor use at other wind-energy facilities that implemented similar protocols to the present study. Similar studies were conducted at 38 other wind-energy facilities in the spring and 33 in the fall. Mean raptor use at other wind-energy facilities ranged from 0.08 to 3.50 birds/20-min. survey in the spring and from 0.08 to 3.37 birds/20-min. survey in the fall (Figures 11 and 12). Mean raptor use at the GWRA was sixth highest compared to the other sites in the spring, and third highest compared to other sites in the fall. Based on the results from these projects a ranking of seasonal raptor mean use was developed as: low (0 – 0.5/survey); low to moderate (0.5 – 1.0/survey); moderate (1.0 – 2.0/survey); high (2.0 – 3.0); and very high (> 3.0). Under this ranking, mean raptor use at GWRA would be considered moderate in the spring and the fall.

Spring raptor use at the GWRA (1.09 birds/20-min survey) is similar to that observed at Swauk Ridge, Reardan, and Desert Claim, Washington (1.01, Erickson et al. 2003; 1.09, WEST 2005b; 1.11, Young et al. 2003b; respectively; Figure 11), indicating that while spring raptor use at the GWRA is higher than at 32 other wind-energy facilities, it is not outside of the norm. The only wind resource areas (WRAs) studied with higher than typical fall raptor use than the GWRA (1.08 birds/20-min survey) are the Altamont Pass WRA, California (Erickson et al. 2002), where annual use averaged 3.38/survey, and the St. Lawrence WRA, New York, where annual raptor use averaged 3.17/survey (Kerns et al. 2007). Only the Hatchet Ridge WRA, California, has a similar raptor use in the fall (0.91; Young et al. 2007a). Fall raptor use at the GWRA is 34.1% of that observed at the St. Lawrence WRA, and 32.3% of that observed at the Altamont Pass WRA. Of the 33 wind-energy facilities with similar raptor use data, only those two have higher raptor use than that observed at the GWRA, while 32 have lower use (Figure 12), indicating that raptor use of this site is relatively high, although not on the same order of magnitude as that observed at the St. Lawrence and Altamont Pass WRAs.

Although high numbers of raptor fatalities have been documented at some wind-energy facilities (e.g. Altamont Pass; Orloff and Flannery 1992; Orloff and Flannery 1996), a review of studies at wind-energy facilities across the US reported that only 3.2% of casualties were raptors (Erickson et al. 2001). Although raptors occur in most areas with the potential for wind-energy development, individual species appear to differ from one another in their susceptibility to collision (NRC 2007). Results from Altamont Pass in California suggest that mortality for some species is not necessarily related to abundance (Orloff and Flannery 1992). American kestrels, red-tailed hawks, and golden eagles were killed more often, and turkey vultures (*Cathartes aura*) were killed less often than predicted, based on abundance alone. A recent report from the Buffalo Gap wind-energy facility in Texas, however, suggests that turkey vultures may show higher susceptibility to collision with larger wind turbines than previously believed for smaller turbines (Tierney 2007). In addition, reports from the High Winds wind-energy facility in California document high American kestrel mortality. Relative use by this species at High Winds is six times that at Altamont Pass (Kerlinger et al. 2005; Orloff and Flannery 1992; Orloff and

Flannery 1996). It is likely that many factors, in addition to abundance, are important in predicting raptor mortality.

Exposure indices may also provide insight into what species might be the most likely turbine casualties; however, the index only considers relative probability of exposure based on abundance, proportion of daily activity spent flying, and proportion of flight height of each species within the zone of risk for turbines likely to be used at the wind-energy facility. This analysis is based on observations of birds during the daylight period, and does not take into consideration flight behavior (e.g. during foraging or courtship) or abundance of nocturnal migrants. It also does not take into consideration habitat selection, the ability to detect and avoid turbines, and other factors that may vary among species and influence likelihood for turbine collision. For these reasons, the actual risk for some species may be lower or higher than indicated by these data.

A regression analysis of raptor use and mortality for eleven new-generation wind-energy facilities, where similar methods were used to estimate raptor use and mortality, found that there was a significant correlation between use and mortality (R^2 = 81.4%; Figure 13). Using this regression to predict raptor collision mortality at the GWRA, based on an adjusted mean raptor use of 1.09 birds/20-min survey, yields an estimated fatality rate of 0.14 raptors/MW/year, or 14 raptor fatalities per year for a 100-MW wind-energy facility. This estimate is similar to the estimated raptor mortality found at the wind-energy facilities of Hopkin's Ridge, Washington (0.14; Young et al. 2007b) and Klondike II, Oregon (0.11; NWC and WEST 2007) (Figure 13). A 90% prediction interval around the GWRA's raptor fatality estimate is 0 to 0.30 raptors/MW/year. The estimated raptor mortality records at the Diablo Winds (0.56; WEST 2006) and High Winds (0.39; Kerlinger et al. 2005), California, wind-energy facilities were the only two facilities with higher estimates than the GWRA (0.14; Figure 13). However, the Diablo Winds and High Winds WRAs also had a substantially higher raptor use (2.9 and 3.51 birds/20-min survey, respectively; Figure 13) than the GWRA currently shows (1.08 in the spring and 1.09 in the fall; Table 3).

Non-Raptor Use and Exposure Risk

Exposure indices of non-raptors indicate American crows are most likely to be exposed to potential collision from wind turbines at the GWRA. Most non-raptors had relatively low exposure indices due to the majority of individuals flying below the likely zone of risk. Given the GWRA's geographic location and overall bird use, it is reasonable to assume that bird fatality rates would be lower than other wind-energy facilities in the Midwest and West (Table 8). Due to the low exposure risks for other species at the GWRA, it is unlikely that non-raptor populations will be adversely affected by direct mortality from the operation of the wind-energy facility.

Greater Sage-grouse Displacement Impacts

Much debate has occurred recently regarding the potential impacts of wind-energy facilities on prairie grouse, including greater sage-grouse. Under a set of voluntary guidelines, the US Fish and Wildlife Service (USFWS) has taken a precautionary approach, and recommends that wind turbines be placed at least five mi (eight km) from known prairie grouse lek locations. The USFWS argues that because prairie grouse evolved in habitats with little vertical structure, placement of tall man-made structures such as wind turbines in occupied prairie grouse habitat may result in a decrease in habitat suitability (USFWS 2004). Some initial research has shown avoidance of a large power plant and associated powerlines by breeding lesser prairie chickens (*Tympanuchus pallidicinctus)* in Kansas (Hagen 2003). The USFWS (2004) describes an unpublished study in which three greater prairie chicken (*Tympanuchus cupido*) leks were active after the construction of three wind turbines in Minnesota. Two of the leks were located within two miles (3.22 kilometers (km)) of the turbines, and one lek was located 0.6 miles (0.27 km) from the turbines. The report describes one hen and a brood using an area immediately adjacent to a turbine. The study took place in an isolated patch of suitable grassland surrounded by unsuitable cropland. The USFWS concluded that the amount of habitat, rather than the presence of wind turbines, was limiting the population. The USFWS (2004) describes the results as potentially indicating that "if other factors are not limiting to Greater Prairie Chickens, turbines might not be avoided elsewhere. However, while birds may persist near turbines, survival of those individuals may be compromised, resulting in a population decline." While the potential exists for wind turbines to displace greater sage-grouse from occupied habitat, well designed studies examining the potential impacts of wind turbines on prairie grouse are lacking. Currently, a large–scale study of wind-energy effects on greater prairie chickens is being conducted at several wind-energy facilities in Kansas. The results of this research will help better define the impacts of wind projects to prairie grouse.

Because there are no leks on or near the GWRA, the project is not likely to affect birds on leks. Results of the greater sage-grouse brood surveys indicated that the GWRA does not provide important brood rearing habitat. Pellet surveys conducted following construction of the wind farm will allow us to determine to what extent, if any, turbines displace greater sage-grouse.

Indirect Effects

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities and suitable habitat. Some studies from wind-energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996, Strickland 2004). The greatest concern with displacement impacts are for wind-energy facilities placed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007), and disturbance appears to impact feeding, resting and migrating birds rather than breeding birds (Crockford 1992). Studies on habitat displacement by wind-energy facilities have concentrated on grassland passerines, waterfowl and raptors (NRC 2007).

Raptor Nesting Disturbance

In addition to possible direct effects on raptors within the study area (discussed above); indirect effects caused by disturbance-type impacts, such as construction activity near an active nest or primary foraging area, also have a potential impact on raptor species. Birds displaced from wind-energy facilities might move to areas with fewer disturbances, but areas of a lower quality, with an overall effect of reducing breeding success. Most studies on raptor displacement at wind-energy facilities, however, indicate effects to be negligible (Howell and Noone 1992, Johnson et al. 2000a, Johnson et al. 2003a, Madders and Whitfield 2006). Notable exceptions to this include a study in Scotland that described territorial golden eagles avoiding the entire wind-energy facility area, except when intercepting non-territorial birds (Walker et al. 2005); evidence of small scale (< 100 m from turbines) and larger scale avoidance of turbines by northern harriers

(*Circus cyaneus*) in the year following construction in Minnesota (Johnson et al. 2000a); and raptor nest densities lower near turbines compared to nest densities in similar habitat away from turbines in Minnesota (Usgaard et al. 1997).

Four of the five golden eagle nests found during surveys of the GWRA are active, as are other raptor nests that occur within a mile of a proposed turbine. An active short-eared owl and ferruginous hawk nest, as well as inactive ferruginous hawk and red-tailed hawk nests were found. Based on the proximity of the active nests to proposed turbines, there is the potential for some disturbance and possibly displacement of nesting raptors.

Displacement of Non-Raptor Bird Species

The presence of wind turbines may alter the landscape so that wildlife use patterns are affected, displacing wildlife away from the project facilities. Some studies from wind-energy facilities in Europe consider displacement effects to have a greater impact on birds than collision mortality (Gill et al. 1996, Strickland 2004). One of the greatest concerns with displacement impacts are for wind-energy facilities placed in grassland or other native habitats (Leddy et al. 1999, Mabey and Paul 2007). Studies concerning displacement of non-raptor species have concentrated on grassland songbirds and waterfowl/waterbirds (Winkelman 1990, Larsen and Madsen 2000, Mabey and Paul 2007, Shaffer and Johnson 2007). Wind-energy facility construction appears to cause small scale local displacement of grassland songbirds; likely due to avoidance of turbine noise and maintenance activities, and reduced habitat effectiveness because of the presence of access roads and large gravel pads surrounding turbines (Leddy 1996, Johnson et al. 2000b). Transect surveys conducted prior to and after construction of wind-energy facilities in the Northern Great Plains found that grassland songbird use was significantly reduced within approximately 164- 328 ft (50-100 m) of turbine strings; areas further away from turbine strings did not have reduced bird use (Shaffer and Johnson 2007).

Effects of wind-energy facilities on displacement of waterfowl and wading birds appear to be mixed. Studies from the Netherlands and Denmark suggest that densities of these types of species near turbines were lower compared to densities in similar habitats away from turbines (Winkelman 1990, Pedersen and Poulsen 1991). However, a study from a facility in England found no effect of wind turbines on populations of cormorant (*Phalacrocorax carbo*), purple sandpipers (*Calidris maritima*), eiders (*Somateria mollissima*) or gulls, although the cormorants were temporarily displaced during construction (Lawrence et al. 2007). At the Buffalo Ridge, Minnesota wind-energy facility, the abundance of several bird groups, including shorebirds and waterfowl, was found to be significantly lower at survey plots with turbines than at plots without turbines (Johnson et al. 2000b). The report concluded that the area of reduced use was limited primarily to those areas within 328 ft (100 meters) of the turbines.

Although construction and operation of the wind-energy facility may displace some groups of birds, the GWRA will be sited in previously altered habitat (reclaimed coal mine), and undisturbed native habitats are abundant in the region. It is unlikely that displacement of birds would result in any population impacts and indirect impacts are expected to be minimal.

Bat Impacts

Potential Impacts
Assessing the potential impacts of wind energy development to bats at the GWRA is complicated by our current lack of understanding of why bats collide with wind turbines (Kunz et al 2007b), combined with the inherent difficulties of monitoring elusive, night-flying animals (O'Shea et al. 2003). To date, monitoring studies of wind projects suggest that a) migratory tree-roosting species (eastern red (*Lasiurus borealis*), hoary, and silver-haired bats) comprise almost 75% of reported bats killed (Kunz et al. 2007*b*), b) the majority of collisions occur during the post-breeding or fall migration season (roughly August and September; Gruver 2002, Johnson et al. 2003*b*), and c) the highest reported fatalities occur at wind facilities located along forested ridge tops in the eastern U.S. (Kunz et al. 2007*b*), although recent studies in agricultural regions of Iowa and Alberta, Canada, report relatively high fatalities as well (Jain 2005, Baerwald 2006).

Post-construction fatality data collected at wind projects appears to be the best available predictor of mortality levels and species composition for proposed wind projects. Some studies of wind projects have recorded both Anabat detections per night and bat mortality (Table 10). The number of bat calls per night as determined from bat detectors shows a rough correlation with bat mortality, but may be misleading because effort, timing of sampling, species recorded, and detector settings (equipment and locations) varies among studies (Kunz et al. 2007b). Thus, our best available estimate of mortality levels at a proposed wind project involves evaluation of our on-site bat acoustic data in terms of activity levels, seasonal variation, species composition, and topographic features of the project area.

Activity
Bat activity within the GWRA (mean = 0.27 bat passes per detector-night) is extremely low compared to activity recorded at most wind-energy projects. Compared to sites in Tennessee, West Virginia, and Iowa, where bat mortality rates were high (Table 10), the activity recorded at the GWRA was much lower, suggesting mortality levels at the GWRA will correspondingly be much lower. Additionally, we expect mortality rates at the GWRA to be lower than the 1.34 bat fatalities/MW/turbine estimated at Foote Creek Rim in Carbon County, Wyoming, where a mean of 2.2 bat passes per detector-night was recorded (Gruver 2002).

Seasonal Variation
The number of bat calls detected per night at the GWRA was low throughout the study period, with a slight increase in activity during September. This apparent peak in activity occurs later than at Foote Creek Rim, Wyoming, where most bat passes occurred in August. Relatively high activity during September at the GWRA, all of which came from low-frequency bats, is probably best explained by migration of bats through the area. Both of the hoary bat calls we identified occurred in late September. Fatality studies of bats at wind-energy facilities in the US have shown a peak in mortality in August and September, and generally lower mortality earlier in the summer (see Johnson 2005). While the survey efforts vary among the different studies, the studies that combine Anabat surveys and fatality surveys show a general association between the timing of increased bat call rates and timing of mortality, with both call rates and mortality peaking during the fall (Table 9). It is expected that bat mortality at the GWRA will be highest in September.

Species Composition
Of the nine species of bat likely to occur in the study area, four are known fatalities at wind-energy facilities (Table 11). Acoustic bat surveys were unable to determine bat species present in the study area (except for hoary bats), but they were able to distinguish high-frequency from low-frequency species. The majority of bat passes at the GWRA were low-frequency bats (85%), suggesting higher relative abundance of species such as hoary, silver-haired, big brown, and Townsend's big-eared bat.

Topographic Features
The proposed wind-energy facility is not located near any large, known bat colonies or other features that are likely to attract large numbers of bats. Additionally, the GWRA does not contain topographic features that may funnel migrating bats, and it is lacking large tracts of forest cover, unlike high-mortality sites in the eastern US. However, the relatively large numbers of bat fatalities recently reported in northern Iowa (Jain 2005) and southwestern Alberta (Baerwald 2006) indicate that an open landscape is no guarantee of low mortality.

CONCLUSION

Based on data collected during this study, raptor use of the GWRA is relatively high compared to several other WRAs in the US, but total avian use is lower than that observed at most other WRAs evaluated throughout the US. Therefore, mortality of non-raptor avian species will likely be low compared to many other WRAs. Golden eagles comprised nearly half (47%) of all raptors observed on site. High use by golden eagles was likely due to the presence of three active nests on artificial platforms within the GWRA. A permit to move these nests structures has been obtained by the USFWS, and all golden eagle nest structures will be moved from the project area prior to constructing turbines. Use of the project area by golden eagles will likely be reduced substantially once these nests are no longer present.

The bat use data indicated much lower bat activity compared to other wind-energy facilities in Wyoming, including the nearby Foote Creek Rim Windpower Project, which estimated 1.34 bat fatalities/MW/year. Bat mortality at the GWRA would therefore likely be lower than that documented at Foote Creek Rim. Furthermore, we expect bat mortality at the GWRA to be much lower than the mortality rate at wind facilities in the eastern US, where activity levels and associated reported fatalities are much higher.

REFERENCES

Arnett, E.B., technical editor. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. A Final Report Submitted to the Bats and Wind Energy Cooperative. Bat Conservation International. Austin, Texas.

Arnett, E. 2007. Report from BWEC on Collaborative Work & Plans. Presentation at the NWCC Wildlife Workgroup Meeting, Boulder Colorado. November 14th, 2007. Conservation International. Information at www.nationwind.org.

Arnett, E.B., W.P. Erickson, J. Kerns, and J. Horn. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. Prepared for the Bats and Wind Energy Cooperative. March 2005.

Baerwald, E. 2006. Bat Fatalities in Southern Alberta. Presented at the Wildlife Research Meeting VI, San Antonio, Texas. National Wind Coordinating Collaborative. November 2006.

Bat Conservation International, Inc. (BCI). 2002. Bat Species: U.S. Bats. Bat Conservation International, Inc., Austin, Texas. www.batcon.org.

BGEPA (Bald and Golden Eagle Protection Act). 1940. 16 United States Code § 668-668d. June 8, 1940.

Demastes, J.W. and J.M. Trainer. 2000. Avian Risk, Fatality, and Disturbance at the IDWGP Wind Farm, Algona, Iowa. Final Report Submitted by the University of Northern Iowa, Cedar Falls, Iowa. 21 pp.

Erickson, W.P., G.D. Johnson, M.D. Strickland, and K. Kronner. 2000. Avian and Bat Mortality Associated with the Vansycle Wind Project, Umatilla County, Oregon: 1999 Study Year. Technical report prepared for Umatilla County Dept. of Resource Services and Development, Pendleton, Oregon. 21pp.

Erickson, W.P., G.D. Johnson, M.D. Strickland, D.P. Young, Jr., K.J. Sernka and R.E. Good. 2001. Avian Collisions with Wind Turbines: A Summary of Existing Studies and Comparisons to Other Sources of Bird Collision Mortality in the United States. National Wind Coordinating Committee (NWCC) Publication and Resource Document. Prepared for the NWCC by WEST, Inc., Cheyenne, Wyoming. August 2001.http://www.nationalwind.org/publications/default.htm http://www.west-inc.com

Erickson, W., G. Johnson, D. Young, D. Strickland, R. Good, M. Bourassa, K. Bay, and K. Sernka. 2002. Synthesis and Comparison of Baseline Avian and Bat Use, Raptor Nesting and Mortality Information from Proposed and Existing Wind Developments. Technical report prepared for Bonneville Power Administration, Portland, Oregon by WEST, Inc., Cheyenne, Wyoming. December 2002. http://www.west-inc.com

Erickson, W.P., B. Gritski, and K. Kronner. 2003a. Nine Canyon Wind Power Project Avian and Bat Monitoring Report, September 2002 - August 2003. Technical report prepared by WEST, Inc., for Energy Northwest and the Nine Canyon Technical Advisory Committee, Benton County, Washington.

Erickson, W., J. Jeffrey, D. Young, K. Bay, R. Good, K. Sernka, and K. Kronner. 2003b. Wildlife Baseline Study for the Kittitas Valley Wind Project: Summary of Results from 2002 Wildlife Surveys. Final Report February 2002– November 2002. Prepared for Zilkha Renewable Energy, Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc. (NWC), Pendleton, Oregon. January 2003.

Erickson, W.P., J. Jeffrey, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Final Report, July 2001 - December 2003. Technical report peer-reviewed by and submitted to FPL Energy, the Oregon Energy Facility Siting Council, and the Washington Stateline Technical Advisory Committee. http://www.west-inc.com

Erickson, W.P., J.D. Jeffrey, and V.K. Poulton. 2008. Avian and Bat Monitoring: Year 1 Report. Puget Sound Energy Wild Horse Wind Project, Kittitas County, Washington. Prepared for Puget Sound Energy, Ellensburg, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 2008.

Evans, W.R. 1998. Acoustic Detection of Nocturnal Bird Migration at a Proposed Wind Turbine Site in North-Central Nebraska. Technical report prepared for NPPD.

Fiedler, J.K. 2004. Assessment of Bat Mortality and Activity at Buffalo Mountain Windfarm, Eastern Tennessee. Thesis. University of Tennessee, Knoxville, Tennessee.

Gannon, W.L., R.E. Sherwin, and S. Haymond. 2003. On the Importance of Articulating Assumptions When Conducting Acoustic Studies of Habitat Use by Bats. Wildlife Society Bulletin 31: 45-61.

Gill, J.A., W.J. Sutherland, and A.R. Watkinson. 1996. A Method to Quantify the Effects of Human Disturbance on Animal Populations. Journal of Applied Ecology 33: 786-792.

Gruver, J.C. 2002. Assessment of Bat Community Structure and Roosting Habitat Preferences for the Hoary Bat (*Lasiurus cinereus*) near Foote Creek Rim, Wyoming. M.S. Thesis. University of Wyoming, Laramie, Wyoming.

Hagen, C.A. 2003. A Demographic Analysis of Lesser Prairie-Chicken Populations in Southwestern Kansas: Survival, Population Viability, and Habitat Use. Ph.D. Dissertation. Division of Biology, College of Arts and Sciences. Kansas State University, 199 pp.

Harvey, M.J., J.S. Altenbach, and T.L. Best. 1999. Bats of the United States. Arkansas Game & Fish Commission and US Fish and Wildlife Service, Arkansas.

Hawrot, R.Y. and J.M. Hanowski. 1997. Avian Assessment Document: Avian Population Analysis for Wind Power Generation Region: 012. Natural Resources Research Institute, Technical Report No. NRRI/TR 97-23.

Hayes, J.P. 1997. Temporal Variation in Activity of Bats and the Design of Echolocation-Monitoring Studies. Journal of Mammalogy 78: 514-524.

Howe, R.W., W. Evans, and A.T. Wolf. 2002. Effects of Wind Turbines on Birds and Bats in Northeastern Wisconsin. Technical report prepared for the Wisconsin Public Service Commission and Madison Gas and Electric Company. 104 pp.

Howell, J.A., J. Noone, and C. Wardner. 1991. Avian Use and Mortality Study, U.S. Windpower Wind Energy Site Development, Montezuma Hills, Solano County, California, Post Construction, Spring 1990 to Spring 1991. Technical report prepared for Solano County Dept. of Environmental Management, Fairfield, California.

Howell, J.A. and J. Noone. 1992. Examination of Avian Use and Mortality at a U.S. Windpower Wind Energy Development Site, Montezuma Hills, Solano County, California. Final Report to Solano County Department of Environmental Management. Fairfield, California. 41 pp

Jain, A. 2005. Bird and Bat Behavior and Mortality at a Northern Iowa Windfarm. M.S. Thesis., Iowa State University, Ames, Iowa.

Johnson, G.D. 2005. A Review of Bat Mortality at Wind-Energy Developments in the United States. Bat Research News 46(2): 45-49.

Johnson, G.D., D.P. Young, Jr., C.E. Derby, W.P. Erickson, M.D. Strickland, and J.W. Kern. 2000a. Wildlife Monitoring Studies, Seawest Windpower Plant, Carbon County, Wyoming, 1995-1999. Technical report prepared for SeaWest Energy Corporation, San Diego, California, and the Bureau of Land Management, Rawlins, Wyoming, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. August 9, 2000. 195 pp. http://www.west-inc.com

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd and D.A. Shepherd. 2000b. Avian Monitoring Studies at the Buffalo Ridge, Minnesota Wind Resource Area: Results of a 4-Year Study. Technical Report prepared for by WEST, Inc. for Xcel Energy, Minneapolis, Minnesota. 262 pp. http://www.west-inc.com

Johnson, G.D., W.P. Erickson, K. Bay, and K. Kronner. 2002. Baseline Ecological Studies for the Klondike Wind Project, Sherman County, Oregon. Prepared for Northwestern Wind Power by WEST, Inc., Cheyenne, Wyoming, and Northwest Wildlife Consultants, Inc., Pendleton, Oregon.

Johnson, G. W. Erickson, J. White, and R. McKinney. 2003a. Avian and Bat Mortality During the First Year of Operation at the Klondike Phase 1 Wind Project, Sherman County, Oregon. Technical report by WEST, Inc for Northwestern Wind Power, Goldendale, Washington.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, and S.A. Sarappo. 2003b. Mortality of Bats at a Large-Scale Wind Power Development at Buffalo Ridge, Minnesota. The American Midland Naturalist 150: 332-342.

Johnson, G.D. and W.P. Erickson. 2004a. Analysis of Potential Wildlife/Wind Plant Interactions, Bighorn Site, Klickitat County, Washington. Prepared for CH2M HILL, Portland, Oregon by WEST, Inc., Cheyenne, Wyoming. August 2004.

Johnson, G.D., M.K. Perlik, W.P. Erickson, and M.D. Strickland. 2004b. Bat Activity, Composition and Collision Mortality at a Large Wind Plant in Minnesota. Wildlife Society Bulletin 32: 1278-1288.

Johnson, G.D., W.P. Erickson, and J.D. Jeffrey. 2006a. Analysis of Potential Wildlife Impacts from the Windy Point Wind Energy Project, Klickitat County, Washington. Unpublished report prepared by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. February 3, 2006.

Johnson, G., J. Eddy, and K. Bay. 2006b. Baseline Avian Use of the Sand Hills Wind Energy Project, Albany County, Wyoming. Summer Breeding Season and Fall Migration 2006. Draft interim report prepared for CH2M Hill, Englewood, Colorado, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. November 6, 2006.

Johnson, G., J. Jeffrey, V. Poulton, and K. Bay. 2006c. Baseline Ecological Studies for the Hoctor Ridge Wind Energy Project, Klickitat County, Washington. Prepared for Windtricity Ventures, LLC., Goldendale, Washington by WEST, Inc., Cheyenne, Wyoming. September 5, 2006.

Johnson, G., J. Jeffrey, V. Poulton, and K. Bay. 2006d. Baseline Ecological Studies for the DNR Wind Energy Project, Klickitat County, Washington. Prepared for Windtricity Ventures, LLC, Goldendale, Washington, by WEST, Inc., Cheyenne, Wyoming. September 5, 2006.

Johnson, G., J. Jeffrey, V. Poulton, and K. Bay. 2006e. Baseline Ecological Studies for the Imrie Ranch South Wind Energy Project, Klickitat County, Washington. Prepared for Windtricity Ventures, LLC, by WEST, Inc., Cheyenne, Wyoming. September 5, 2006.

Johnson, G., J. Jeffrey, J. Baker, and K. Bay. 2007. Baseline Avian Studies for the Windy Flats Wind Energy Project, Klickitat County, Washington. Prepared for Windy Point Partners, LLC, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. May 29, 2007.

Kerlinger, P. 1997. A Study of Avian Fatalities at the Green Mountain Power Corporation's Searsburg, Vermont Windpower Facility - 1997. Prepared for Vermont Department of Public Service, Green Mountain Power Corporation, National Renewable Energy Laboratory and Vermont Environmental Research Associates. 12 pp.

Kerlinger, P., L. Culp, and R. Curry. 2005. Post-Construction Avian Monitoring Study for the High Winds Wind Power Project Solano County, California. Prepared for High Winds LLC, by Curry and Kerlinger, LLC. 70 pp.

Kerlinger, P. and J. Dowdell. 2003. Breeding Bird Survey for the Flat Rock Wind Power Project, Lewis County, New York. Prepared for the Atlantic Renewable Energy Corporation.

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual Report for 2003. Technical report prepared for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee.

Kerns, J., W.P. Erickson, and E.B. Arnett. 2005. Bat and Bird Fatality at Wind Energy Facilities in Pennsylvania and West Virginia. *In*: Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Bat Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. A Final Report Submitted to the Bats and Wind Energy Cooperative. Arnett, E.B., Technical Ed. Bat Conservation International, Austin, Texas. Pp 24-95.

Kerns, J.J., D.P. Young, Jr., C.S. Nations, and V.K. Poulton. 2007. Avian and Bat Studies for the Proposed St. Lawrence Windpower Project, Jefferson County, New York. Final Report April 2006 – May 2007. Prepared for St. Lawrence Windpower, LLC., Cape Vincent, New York, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. . August 2007.

Koford, R., A. Jain, G. Zenner. 2005. Avian Mortality Associated with the Top of Iowa Wind Farm. Progress Report, Calendar Year 2004. Iowa State University and Iowa Department of Natural Resources.

Kunz, T. H., E. B. Arnett, B. M. Cooper, W. P. Erickson, R. P. Larkin, T. Mabee, M. L. Morrison, M. D. Strickland, and J. M. Szewczak. 2007*a*. Assessing Impacts of Wind-energy Development on Nocturnally Active Birds and Bats: A Guidance Document. *Journal of Wildlife Management,* 71:2449-2486.

Kunz, T. H., E.B Arnett, W P. Erickson, A.R. Hoar, G.D. Johnson, R.P. Larkin, M.D. Strickland, R.W. Thresher, and M.D. Tuttle. 2007*b*. Ecological impacts of wind energy development on bats: questions, research needs, and hypotheses. *Frontiers in Ecology and the Environment* 5:315-324.

Larsen, J.K. and J. Madsen. 2000. Effects of Wind Turbines and Other Physical Elements on Field Utilization by Pink-Footed Geese (*Anser brachyrhynchus*): A Landscape Perspective. Landscape Ecology 15: 755-764.

Leddy, K.L. 1996. Effects of Wind Turbines on Nongame Birds in Conservation Reserve Program Grasslands in Southwestern Minnesota. M.S. Thesis. South Dakota State University, Brookings. 61 pp.

Leddy, K.L., K.F. Higgins, and D.E. Naugle. 1999. Effects of Wind Turbines on Upland Nesting Birds in Conservation Reserve Program Grasslands. Wilson Bulletin 111(1): 100-104.

Mabey, S. and E. Paul. 2007. Impact of Wind Energy and Related Human Activities on Grassland and Shrub-Steppe Birds. A Critical Literature Review Prepared for the NWCC. 183 pp.

Madders, M. and D.P. Whitfield. 2006. Upland Raptors and the Assessment of Wind Farm Impacts. Ibis 148: 43-56.

MBTA (Migratory Bird Treaty Act). 1918. 16 United States Code § 703-712. July 13, 1918.

McCrary, M.D., R.L. McKernan, and R.W. Schreiber. 1986. San Gorgonio Wind Resource Area: Impacts of Commercial Wind Turbine Generators on Birds, 1985 Data Report. Technical report prepared for Southern California Edison Company. 33pp.

National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects. National Academies Press. Washington, D.C.

Neff, D.J. 1968. The Pellet-Group Count Technique for Big Game Trend, Census and Distribution: A Review. Journal of Wildlife Management 32: 597-614.

Nicholson, C.P. 2001. Buffalo Mountain Windfarm Bird and Bat Mortality Monitoring Report: October 2000-September 2001. Tennessee Valley Authority, Knoxville.

Nicholson, C.P. 2003. Buffalo Mountain Windfarm Bird and Bat Mortality Monitoring Report: October 2001 - September 2002. Tennessee Valley Authority. Knoxville, Tennessee.

National Research Council (NRC). 2007. Environmental Impacts of Wind-Energy Projects. National Academies Press. Washington, D.C.

Northwest Wildlife Consultants, Inc.(NWC) and Western EcoSystems Technology, Inc.(WEST). 2004. Ecological Baseline Studies for the Roosevelt Wind Project, Klickitat County, Washington. Final Report. Prepared by NWC, Pendleton, Oregon, and WEST, Inc., Cheyenne, Wyoming. September 2004.

Northwest Wildlife Consultants, Inc. (NWC) and Western EcoSystems Technology, Inc.(WEST). 2005a. Ecological Baseline Studies and Wildlife Impact Assessment for the White Creek Wind Power Project, Klickitat County, Washington. Prepared for Last Mile Electric Cooperative, Goldendale, Washington, by Northwest Wildlife Consultants, Inc., Goldendale, Washington, and Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. January 12, 2005.

Northwest Wildlife Consultants, Inc. (NWC) and Western EcoSystems Technology, Inc.(WEST). 2005b. Wildlife Baseline Study for the Leaning Juniper Wind Power Project, Gilliam County, Oregon. Prepared for PPM Energy, Portland, Oregon and CH2M HILL, Portland, Oregon by NWC, Pendleton, Oregon, and WEST, Inc., Cheyenne, Wyoming. November 3, 2005.

Northwest Wildlife Consultants, Inc. (NWC) and Western EcoSystems Technology, Inc. (WEST). 2007. Avian and Bat Monitoring Report for the Klondike II Wind Power Project. Sherman County, Oregon. Prepared for PPM Energy, Portland, Oregon. Managed and conducted by NWC, Pendleton, Oregon. Analysis conducted by WEST, Cheyenne, Wyoming. July 17, 2007.

National Wind Coordinating Committee (NWCC). 2004. Wind Turbine Interactions with Birds and Bats: A Summary of Research Results and Remaining Questions. Fact Sheet, Second Edition. http://www.nationalwind.org/publications/default.htm

Orloff, S. and A. Flannery. 1992. Wind Turbine Effects on Avian Activity, Habitat Use, and Mortality in Altamont Pass and Solano County Wind Resource Areas, 1989-1991. Final Report P700-92-001 to Alameda, Contra Costa and Solano Counties and the California Energy Commission, Sacramento, California, by Biosystems Analysis, Inc., Tiburon, California. March 1992.

Orloff, S. and A. Flannery. 1996. A Continued Examination of Avian Mortality in the Altamont Pass Wind Resource Area. P700-96-004cn. Report from Ibis Environmental Services, Santa Cruz, California, and BioSystems Analysis, Inc., Tiburon, California, for the California Energy Commission, Sacramento, California. August 1996.

O'Shea, T.J., M.A. Bogan, and L.E. Ellison. 2003. Monitoring trends in bat populations of the United States and territories: status of the science and recommendations for the future. Wildlife Society Bulletin 31:16-29.

Pedersen, M.B. and E. Poulsen. 1991. Impact of a 90m/2mw Wind Turbine on Birds - Avian Responses to the Implementation of the Tjaereborg Wind Turbine at the Danish Wadden Sea. Dansek Vildundersogelser, Haefte 47. Miljoministeriet & Danmarks Miljoundersogelser.

Reynolds, R.T., J.M. Scott, and R.A. Nussbaum. 1980. A Variable Circular-Plot Method for Estimating Bird Numbers. Condor 82(3): 309-313.

Rowland, K. 2006. Alberta Bat Fatalities Studied. North American Windpower 3(1): 3-4.

SD Wildlife Conservation Plan. South Dakota Game, Fish and Parks. Available online at [http://www.sdgfp.info/Wildlife/Diversity/SDSitingGuidelinesOct2007.pdf].

Shaffer, J.A. and D.H. Johnson. 2007. Effects of Wind Developments on Grassland Birds in Native Habitats in the Northern Great Plains. Presentation at the 2007 TWS meeting, Tucson, Arizona.

Smallwood, K. S. and C. G. Thelander. 2004. Developing Methods to Reduce Bird Fatalities in the Altamont Wind Resource Area. Final report by BioResource Consultants to the California Energy Commission, Public Interest Energy Research-Environmental Area, under Contract No. 500-01-019 (L. Spiegel, Project Manager).

Strickland, M.D. 2004. Non-Fatality and Habitat Impacts on Birds from Wind Energy Development. S. S. Schwartz, ed. *In*: Proceedings of the Wind Energy and Birds/Bats Workshop: Understanding and Resolving Bird and Bat Impacts. Washington, DC. May 18-19, 2004. September 2004. Prepared by RESOLVE, Inc. Washington, D.C.

Tierney, R. 2007. Buffalo Gap I Wind Farm Bird Mortality Study, February 2006 - January 2007, Final Survey Report. Prepared for AES Seawest, Inc., by TRC.

US Fish and Wildlife Service (USFWS). 2004. Prairie Grouse Leks and Wind Turbines: U.S. Fish and Wildlife Service Justification for a 5-Mile Buffer from Leks; Additional Grassland Songbird Recommendations. An unpublished briefing paper.

Usgaard, R.E., D.E. Naugle, R.G. Osborn, and K.F. Higgins. 1997. Effects of Wind Turbines on Nesting Raptors at Buffalo Ridge in Southwestern Minnesota. Proceedings of the South Dakota Academy of Science 76: 113-117.

Walker, D., M. McGrady, A. McCluskie, M. Madders, and D.R.A. McLeod. 2005. Resident Golden Eagle Ranging Behaviour Before and After Construction of a Windfarm in Argyll. Scottish Birds 25: 24-40.

Western Ecosystems Technology, Inc. (WEST). 2005a. Ecological Baseline Study at the Elkhorn Wind Power Project. Exhibit A. Final report prepared for Zilkha Renewable Energy, LLC., Portland, Oregon, by WEST, Cheyenne, Wyoming. June 2005.

Western EcoSystems Technology, Inc. (WEST). 2005b. Ecological Baseline Study for the Proposed Reardan Wind Project, Lincoln County, Washington. Draft Final Report. Prepared for Energy Northwest, Richland, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. June 2005.

Western EcoSystems Technology, Inc. (WEST). 2006. Diablo Winds Wildlife Monitoring Progress Report, March 2005 - February 2006. Technical report submitted to FPL Energy and Alameda County California. WEST. Cheyenne, Wyoming.

Western EcoSystems Technology, Inc. (WEST). 2007. Baseline Avian Studies for the Orion Sherman/Biglow Canyon North Wind Power Project. Draft Report. Prepared For Orion Energy by WEST, Inc. Cheyenne, Wyoming. 25 January 2007.

Western EcoSystems Technology, Inc. (WEST) and the Colorado Plateau Research Station (CPRS). 2006. Avian Studies for the Proposed Sunshine Wind Park, Coconino County, Arizona. Prepared for Sunshine Arizona Wind Energy, LLC., Flagstaff, Arizona, by WEST, Cheyenne, Wyoming, and the Colorado Plateau Research Station, Northern Arizona University, Flagstaff, Arizona. May 2006.

Western EcoSystems Technology, Inc. (WEST), EDAW, Inc., and Bloom Biological, Inc. 2007b. Baseline Avian Use and Risk Assessment for the Homestead Wind Energy Project, Kern County, California. 2005 – 2006. Prepared for Horizon Wind Energy by Western EcoSystems Technology, Inc. (WEST), EDAW, Inc., San Diego, California, and Bloom Biological, Inc., Santa Anna, California. April 19, 2007.

Western EcoSystems Technology, Inc. (WEST) and Northwest Wildlife Consultants, Inc. (NWC). 2003a. Analysis of Potential Avian/Wind Plant Interactions in Klickitat County, Washington. Supplement to the Klickitat County Programmatic Environmental Impact Statement. Prepared for the Resource Development Department, Klickitat County, Goldendale, Washington, by WEST, Cheyenne, Wyoming, and NWC, Pendleton, Oregon. May 2003.

Western EcoSystems Technology, Inc. (WEST) and Northwest Wildlife Consultants, Inc (NWC). 2003b. Nine Canyon Wind Power Project Avian and Bat Monitoring Report, September 2002-August 2003. Technical report prepared for Nine Canyon TAC, and Energy Northwest.

Western EcoSystems Technology, Inc. (WEST) and Northwest Wildlife Consultants, Inc. 2004. Stateline Wind Project Wildlife Monitoring Final Report, July 2001-December 2003. Technical report prepared for FPL Energy, Stateline TAC, and Oregon Dept. of Energy.

White, E.P. and S.D. Gehrt. 2001. Effects of Recording Media on Echolocation Data from Broadband Bat Detectors. Wildlife Society Bulletin 29: 974-978.

Winkelman, E. 1990. Impact of the Wind Park near Urk, Netherlands, on Birds: Bird Collision Victims and Disturbance of Wintering Fowl. International Ornithological Congress 20: 402-403.

Young, D.P. Jr., W.P. Erickson, R.E. Good., M.D. Strickland, and G.D. Johnson. 2003a. Avian and Bat Mortality Associated with the Initial Phase of the Foote Creek Rim Wind Power Project, Carbon County, Wyoming. Technical report prepared for PacifiCorp, Inc., Portland, OR, SeaWest Windpower Inc., San Diego, California, and BLM, Rawlins District Office, Rawlins, Wyoming.

Young, J., D.P., W. P. Erickson, J. D. Jeffrey, K. Bay, R. E. Good, and E. G. Lack. 2003b. Avian and Sensitive Species Baseline Study Plan and Final Report. Eurus Combine Hills Turbine Ranch, Umatilla County, Oregon. Technical report prepared for Eurus Energy America Corporation, San Diego, California and Aeropower Services, Inc., Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. March 10, 2003.

Young, D. P., Jr., W. P. Erickson, K. J. Bay, J. D. Jeffrey, B. G. Lack, and H. H. Sawyer. 2003c. Baseline Avian Studies for the Proposed Desert Claim Wind Power Project, Kittitas County, Washington. Final Report. Prepared for Desert Claim Wind Power, LLC, Ellensburg, Washington, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 2003.

Young, D.P. Jr., W.P. Erickson, M.D. Strickland, R.E. Good, and K.J. Sernka. 2003d. Comparison of Avian Responses to UV-Light-Reflective Paint on Wind Turbines. Subcontract report to NREL, Golden Colorado.

Young, D. P., Jr., W.P. Erickson, K.J. Bay, J.D. Jeffrey, B.G. Lack, R.E. Good, and H.H. Sawyer. 2003e. Baseline Avian Studies for the Proposed Hopkins Ridge Wind Project, Columbia County, Washington. Final Report, March 2002 - March 2003. Prepared for RES North America, LLC., Portland, Oregon, by Western EcoSystems Technology, Inc.(WEST), Cheyenne, Wyoming. April 30, 2003.

Young, D.P., Jr., C.S. Nations, V.K. Poulton, J. Kerns, and L. Pavilonis. 2006. Avian and Bat Studies for the Proposed Dairy Hills Wind Project, Wyoming County, New York. Final Report, April - October 2005. Prepared for Horizon Wind Energy, Albany, New York, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. April 2006.

Young, David P., Jr., G. D. Johnson, V. K. Poulton, and K. Bay. 2007a. Ecological Baseline Studies for the Hatchet Ridge Wind Energy Project, Shasta County, California. Prepared for Hatchet Ridge Wind, LLC, Portland, Oregon by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. August 31, 2007.

Young, D.P. Jr., W.P. Erickson, J.D. Jeffrey, and V.K. Poulton. 2007b. Puget Sound Energy, Hopkins Ridge Wind Project Phase 1, Post-Construction Avian and Bat Monitoring, First Annual Report, January - December 2006. Technical Report prepared by WEST, Inc., Cheyenne, Wyoming, for Puget Sound Energy.

Young, David P., Jr., V. K. Poulton, and K. Bay. 2007c. Ecological Baseline Studies Report. Proposed Dry Lake Wind Project, Navajo County, Arizona. Prepared for PPM Energy, Portland, Oregon, by Western EcoSystems Technology, Inc. (WEST), Cheyenne, Wyoming. July 1, 2007.

Table 1. Summary of bird use, species richness, and sample size by season and overall during the fixed point bird use surveys at the GWRA, April 18, 2007– November 14, 2007.

Season	# of Visits	Mean Use	# Species /Survey	# Species	# Surveys Conducted
Spring	7	4.18	2.43	19	78
Fall	9	7.98	1.68	16	108
Overall	**16**	**6.32**	**2.01**	**26**	**186**

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed point bird use surveys in the GWRA, April 18, 2007– November 14, 2007.

		Spring		Fall		Total	
Species/Type	**Scientific Name**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**
Shorebirds		**1**	**1**	**0**	**0**	**1**	**1**
killdeer	*Charadrius vociferus*	1	1	0	0	1	1
Raptors		**88**	**84**	**118**	**104**	**206**	**188**
Accipiters		*1*	*1*	*0*	*0*	*1*	*1*
sharp-shinned hawk	*Accipter striatus*	1	1	0	0	1	1
Buteos		*11*	*9*	*34*	*28*	*45*	*37*
ferruginous hawk	*Buteo regalis*	4	3	10	7	14	10
red-tailed hawk	*Buteo jamaicensis*	5	4	16	14	21	18
rough-legged hawk	*Buteo lagopus*	0	0	8	7	8	7
unidentified buteo		2	2	0	0	2	2
Northern Harrier		*29*	*28*	*19*	*19*	*48*	*47*
northern harrier	*Circus cyaneus*	29	28	19	19	48	47
Eagles		*42*	*41*	*55*	*47*	*97*	*88*
golden eagle	*Aquila chrysaetos*	42	41	55	47	97	88
Falcons		*5*	*5*	*10*	*10*	*15*	*15*
American kestrel	*Falco sparverius*	2	2	8	8	10	10
prairie falcon	*Falco mexicanus*	3	3	2	2	5	5
Upland Gamebirds		**0**	**0**	**13**	**2**	**13**	**2**
greater sage-grouse	*Centrocercus urophasianus*	0	0	13	2	13	2
Doves/Pigeons		**18**	**6**	**0**	**0**	**18**	**6**
mourning dove	*Zenaida macroura*	18	6	0	0	18	6
Passerines		**225**	**166**	**731**	**148**	**956**	**314**
American crow	*Corvus brachyrhynchos*	0	0	126	4	126	4
American goldfinch	*Carduelis tristis*	5	1	0	0	5	1
black-billed magpie	*Pica pica*	0	0	1	1	1	1
Brewer's blackbird	*Euphagus cyanocephalus*	20	8	0	0	20	8
Brewer's sparrow	*Spizella breweri*	3	3	0	0	3	3
cliff swallow	*Petrochelidon pyrrhonota*	2	2	0	0	2	2
common raven	*Corvus corax*	0	0	12	3	12	3

Table 2. Total number of groups and individuals for each bird type and species by season and overall during the fixed point bird use surveys in the GWRA, April 18, 2007– November 14, 2007.

		Spring		Fall		Total	
Species/Type	**Scientific Name**	**# obs**	**# grps**	**# obs**	**# grps**	**# obs**	**# grps**
European starling	*Sturnus vulgaris*	0	0	20	3	20	3
horned lark	*Eremophila alpestris*	32	27	545	113	577	140
lark bunting	*Calamospiza melanocorys*	23	9	0	0	23	9
mountain chickadee	*Poecile gambeli*	0	0	1	1	1	1
rock wren	*Salpinctes obsoletus*	1	1	0	0	1	1
sage thrasher	*Oreoscoptes montanus*	12	2	0	0	12	2
unidentified sparrow		0	0	1	1	1	1
vesper sparrow	*Pooecetes gramineus*	22	22	3	3	25	25
western meadowlark	*Sturnella neglecta*	105	91	22	19	127	110
Overall		**332**	**257**	**862**	**254**	**1,194**	**511**

Table 3. Mean bird use (number/plot/20-min survey), percent of total composition (%), and frequency of occurrence (%) for each bird type and species by season during the fixed point bird use surveys at the GWRA, April 18, 2007 – November 14, 2007.

	Use		% Composition		% Frequency	
Species	**Spring**	**Fall**	**Spring**	**Fall**	**Spring**	**Fall**
Shorebirds	**0.01**	**0**	**0.3**	**0**	**1.4**	**0**
killdeer	0.01	0	0.3	0	1.4	0
Raptors	**1.08**	**1.09**	**25.9**	**13.7**	**61.2**	**59.3**
Accipiters	*0.01*	*0*	*0.3*	*0*	*1.4*	*0*
sharp-shinned hawk	0.01	0	0.3	0	1.4	0
Buteos	*0.15*	*0.31*	*3.6*	*3.9*	*9.5*	*24.1*
ferruginous hawk	0.06	0.09	1.4	1.2	4.3	6.5
red-tailed hawk	0.07	0.15	1.6	1.9	5.2	12.0
rough-legged hawk	0	0.07	0	0.9	0	6.5
unidentified buteo	0.03	0	0.7	0	1.4	0
Northern Harrier	*0.38*	*0.18*	*9.0*	*2.2*	*22.4*	*17.6*
northern harrier	0.38	0.18	9.0	2.2	22.4	17.6
Eagles	*0.47*	*0.51*	*11.3*	*6.4*	*36.2*	*33.3*
golden eagle	0.47	0.51	11.3	6.4	36.2	33.3
Falcons	*0.07*	*0.09*	*1.6*	*1.2*	*6.7*	*7.4*
American kestrel	0.03	0.07	0.6	0.9	2.6	5.6
prairie falcon	0.04	0.02	1.0	0.2	4.0	1.9
Upland Gamebirds	**0**	**0.12**	**0**	**1.5**	**0**	**0.9**
greater sage grouse	0	0.12	0	1.5	0	0.9
Doves/Pigeons	**0.22**	**0**	**5.2**	**0**	**6.2**	**0**
mourning dove	0.22	0	5.2	0	6.2	0
Passerines	**2.87**	**6.77**	**68.6**	**84.8**	**89.3**	**63.9**
American crow	0	1.17	0	14.6	0	2.8
American goldfinch	0.06	0	1.4	0	1.2	0
black-billed magpie	0	0.01	0	0.1	0	0.9
Brewer's blackbird	0.24	0	5.7	0	7.1	0
Brewer's sparrow	0.04	0	0.9	0	3.6	0
cliff swallow	0.03	0	0.6	0	2.6	0
common raven	0	0.11	0	1.4	0	2.8
European starling	0	0.19	0	2.3	0	2.8
horned lark	0.42	5.05	10.0	63.2	28.1	55.6
lark bunting	0.28	0	6.7	0	7.6	0
mountain chickadee	0	0.01	0	0.1	0	0.9
rock wren	0.01	0	0.3	0	1.2	0
sage thrasher	0.17	0	4.0	0	2.6	0
unidentified sparrow	0	0.01	0	0.1	0	0.9
vesper sparrow	0.27	0.03	6.4	0.3	23.1	1.9
western meadowlark	1.36	0.20	32.6	2.6	80.5	14.8
Overall	**4.18**	**7.98**	**100.0**	**100.0**		

Table 4. Flight height characteristics by bird type during the fixed point bird use surveys at the GWRA, April 18, 2007– November 14, 2007.

Bird Type	# Obs Flying	# Groups Flying	Mean Flight Height	% Obs Flying	% within Flight Height Categories 0-82 ft	82-410 ft[a]	> 410 ft
Shorebirds	1	1	25.00	100.0	0	100.0	0
Raptors	165	183	95.99	91.0	34.4	33.9	31.7
Accipiters	*1*	*1*	*20.00*	*100.0*	*100.0*	*0*	*0*
Buteos	*34*	*42*	*173.79*	*93.3*	*21.4*	*26.2*	*52.4*
Northern Harrier	*46*	*47*	*35.26*	*97.9*	*68.1*	*21.3*	*10.6*
Eagles	*69*	*78*	*104.07*	*84.8*	*19.2*	*44.9*	*35.9*
Falcons	*15*	*15*	*73.73*	*100.0*	*40.0*	*40.0*	*20.0*
Upland Gamebirds	1	12	10.00	92.3	100.0	0	0
Doves/Pigeons	4	10	2.00	55.6	100.0	0	0
Passerines	154	774	11.04	81.0	77.3	22.2	0.5
Overall	**325**	**980**	**54.10**	**82.4**	**69.7**	**24.0**	**6.3**

[a]ZOR, 82-410 ft above ground level

Table 5. Relative exposure index and flight characteristics by species during the fixed point bird use surveys at the GWRA, April 18, 2007– November 14, 2007.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Initially in ZOR[a]	Exposure Index	% Within ZOR at Any Time
American crow	4	0.66	100.0	100.0	0.66	100.0
golden eagle	69	0.49	84.8	44.9	0.19	65.4
European starling	2	0.10	95.0	84.2	0.08	84.2
horned lark	107	3.02	94.3	2.4	0.07	2.4
northern harrier	46	0.26	97.9	21.3	0.06	40.4
Brewer's blackbird	6	0.10	90.0	50.0	0.05	50.0
common raven	3	0.06	100.0	66.7	0.04	66.7
ferruginous hawk	9	0.08	92.9	46.2	0.03	76.9
American kestrel	10	0.05	100.0	60.0	0.03	70.0
red-tailed hawk	16	0.11	90.5	15.8	0.02	21.1
rough-legged hawk	7	0.04	100.0	25.0	0.01	50.0
killdeer	1	0.01	100.0	100.0	0.01	100.0
American goldfinch	1	0.03	100.0	0	0	0
cliff swallow	2	0.01	100.0	0	0	0
greater sage grouse	1	0.07	92.3	0	0	0
lark bunting	3	0.12	73.9	0	0	0
mountain chickadee	1	0.01	100.0	0	0	0
mourning dove	4	0.09	55.6	0	0	0
prairie falcon	5	0.03	100.0	0	0	0
sharp-shinned hawk	1	0.01	100.0	0	0	100.0
unidentified buteo	2	0.01	100.0	0	0	0
unidentified sparrow	1	0.01	100.0	0	0	0
vesper sparrow	5	0.13	20.0	0	0	0
western meadowlark	19	0.71	18.9	0	0	0
Brewer's sparrow	0	0.02	0	0	0	0

Table 5. Relative exposure index and flight characteristics by species during the fixed point bird use surveys at the GWRA, April 18, 2007– November 14, 2007.

Species	# Groups Flying	Overall Mean Use	% Flying	% Flying Initially in ZOR[a]	Exposure Index	% Within ZOR at Any Time
black-billed magpie	0	0.01	0	0	0	0
rock wren	0	0.01	0	0	0	0
sage thrasher	0	0.07	0	0	0	0

[a]ZOR, 82-410 ft above ground level.

Table 6. Greater sage-grouse observed during sage-grouse brood surveys, July 18 – August 10, 2007.

Date	Male	Female	Young	UTME	UTMN
18-Jul-07	0	1	4	435045	4762399
18-Jul-07	0	2	10	430356	4770781
18-Jul-07	0	1	2	431472	4766583
18-Jul-07	0	2	2	432132	4765983
10-Aug-07	0	0	1	434326	4763298
10-Aug-07	3	0	0	432727	4764894
Total	**3**	**6**	**19**		

Table 7. Results of acoustical bat surveys conducted at the GWRA, August 3 to October 16, 2007.

Anabat Location	# of Hi Freq Bat Passes	# of Lo Freq Bat Passes	Total Bat Passes	Detector-Nights	Bat Passes/ Detector-night
1 (south)	1	12	13	74	0.18
2 (north)	5	23	28	68	0.41
Total	**6**	**35**	**41**	**142**	**0.29**

Table 8. All bird and raptor fatality estimates for several wind-energy facilities in the US.

Facility Name	No. of Turbines	No. MW	Birds Fatalities /Turbine	Birds Fatalities /MW	Raptor Fatalities /Turbine	Raptor Fatalities /MW
Altamont, CA[1]	5,400	518	0.9	8.1	0.14	1.50
Montezuma Hills, CA[2]	600	60	NA	NA	0.05	0.48
San Gorgonio, CA[3]	2,900	300	2.31	9.22	0.010	0.04
Stateline, OR/WA[4]	454	300	1.93	2.56	0.05	0.08
Vansycle, OR[5]	38	25	0.63	0.96	0	0
Klondike, OR[6]	16	24	1.42	0.95	0	0
Nine Canyon, WA[7]	37	48	3.59	2.76	0.06	0.05
Foote Creek Rim, WY Phase I and II[8, 9]	72	43	1.50	2.50	0.03	0.05
Foote Creek Rim, WY Phase III[9]	33	25	1.49	1.99	0.04	0.06
Wisconsin (MG&E and PSC) [10]	31	20	1.30	1.97	0	0
Buffalo Ridge, MN, Phase I[11]	73	22	0.98	3.27	0.01	0.04
Buffalo Ridge, MN, Phase II[11]	143	107	2.27	3.03	0	0
Buffalo Ridge, MN, Phase III[11]	139	104	4.45	5.93	0	0
Buffalo Mountain, TN[12]	3	2	7.70	11.55	0	0
Mountaineer, WV[13]	44	68	4.04	3.00	NA	NA
Top of Iowa, IA[14]	89	80	0.65	0.72	0.01	0.01

[1]Smallwood and Thelander 2004; [2]Howell et al. 1991; [3]McCrary et al. 1986; [4]WEST, Inc. and Northwest Wildlife Consultants, Inc. 2004; [5]Erickson et al. 2000; [6]Johnson et al. 2003a; [7]WEST, Inc. and Northwest Wildlife Consultants, Inc. 2003b; [8]Young et al. 2003a; [9]Young et al. 2003d; [10]Howe et al. 2002; [11]Johnson et al. 2000b; [12]Nicholson 2001; [13]Kerns and Kerlinger 2004; [14]Koford et al. 2005.

Table 9. Wind-energy facilities in the US with both pre-construction Anabat sampling data and post-construction mortality data for bat species (adapted from Kunz et al. 2007b).

Wind-Energy Facility	Activity (#/detector night)	Mortality (bats/turbine/year)	Reference
Glenrock, WY	0.27		This study
Foote Creek Rim, WY	2.2	1.3	Gruver 2002
Buffalo Ridge, MN	2.1	2.2	Johnson et al 2004b
Buffalo Mountain, TN	23.7	20.8	Fiedler 2004
Top of Iowa, IA	34.9	10.2	Koford et al. 2005
Mountaineer, WV	38.3	38.0	Arnett et al. 2005

Table 10. Bat mortality estimates at US wind-energy facilities.

Location and Number of Turbines	Turbine Size	Year	Number of Bat Fatalities Found	Annual Bat Fatalities per Turbine	Annual Bat Fatalities per MW
Buffalo Ridge, MN Phase 1 73 turbines[1,2,3]	330 kw 53 m high	1994-1998	20	0.1	0.3
Buffalo Ridge, MN Phase 2&3 281 turbines[3,4,5]	750 kw 74 m high	1998-2002	400	2.0	2.7
Kewaunee County, WI 31 turbines[6]	660 kw 89 m high	1999-2001	72	4.3	6.5
Foote Creek Rim, WY 105 turbines[7,8,9,10]	660 kw 61 m high	1999-2002	135	1.3	2.0
Buffalo Mountain, TN 3 turbines[11, 12]	660 kw 89 m high	2001-2003	119	19.7	29.8
Mountaineer, WV 44 turbines[13]	1.5 MW 102 m high	2003	475	40.9	27.3
Stateline, OR/WA border 399 turbines[14]	660 kw 74 m high	1999-2003	150	1.1	1.7
Klondike, OR[15] 16 turbines	1.5 MW 100 m high	2002	6	1.2	0.8
Vansycle, OR[16] 38 turbines	660 kw 74 m high	1999	28	0.7	1.1
Nine Canyon, WA[17] 37 turbines	1.3 MW 91 m high	2003	27	3.2	2.5

[1]Osborn et al. 1996; [2]Johnson et al. 2000b; [3]Johnson et al. 2003b; [4]Johnson et al. 2003c; [5]Krenz and McMillan 2000; [6]Howe et al. 2002; [7]Johnson et al. 2000a; [8]Young et al. 2002; [9]Young et al. 2003a; [10]Gruver 2002; [11]Nicholson 2001; [12]Nicholoson 2003; [13]Kerns and Kerlinger 2004; [14]Erickson et al. 2004; [15]Johnson et al. 2003a; [16]Erickson et al. 2000; [17]Erickson et al. 2003a.

Table 11. Bat species determined from range-maps (Harvey et al. 1999; BCI website) as likely to occur within the GWRA, sorted by call frequency.

High-frequency (≥ 35 kHz)		Low frequency (< 35 kHz)	
western small-footed bat	*Myotis ciliolabrum*	Townsend's big-eared bat	*Corynorhinus townsendii*
western long-eared bat	*Myotis evotis*	big brown bat†	*Eptesicus fuscus*
little brown bat†	*Myotis lucifugus*	hoary bat*†	*Lasiurus cinereus*
fringed bat	*Myotis thysanodes*	silver-haired bat*†	*Lasionycteris noctivagans*
long-legged bat	*Myotis volans*		

*long-distance migrant; †species known to have been killed at wind-energy facilities

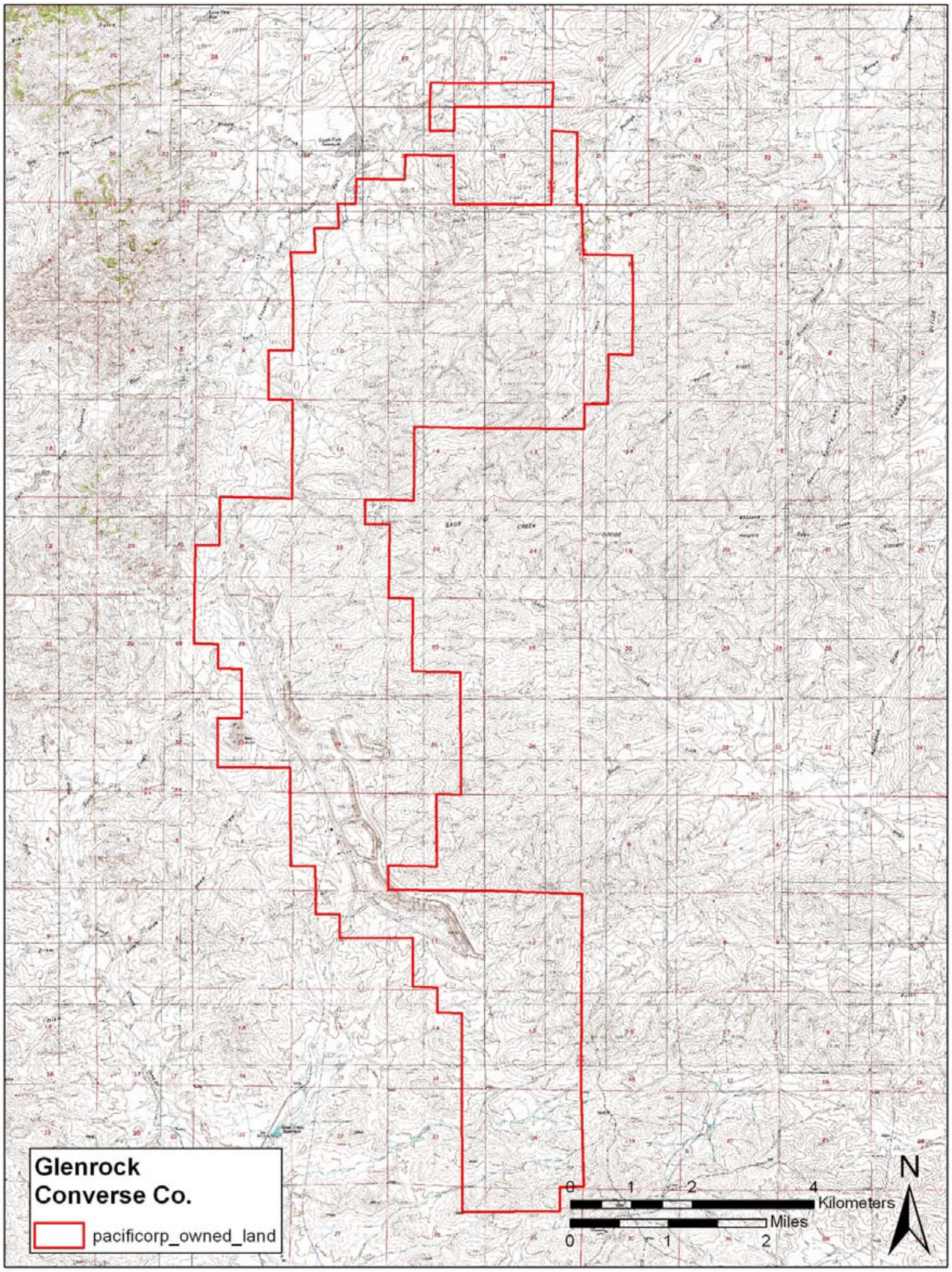


Figure 1. Location of the GWRA.

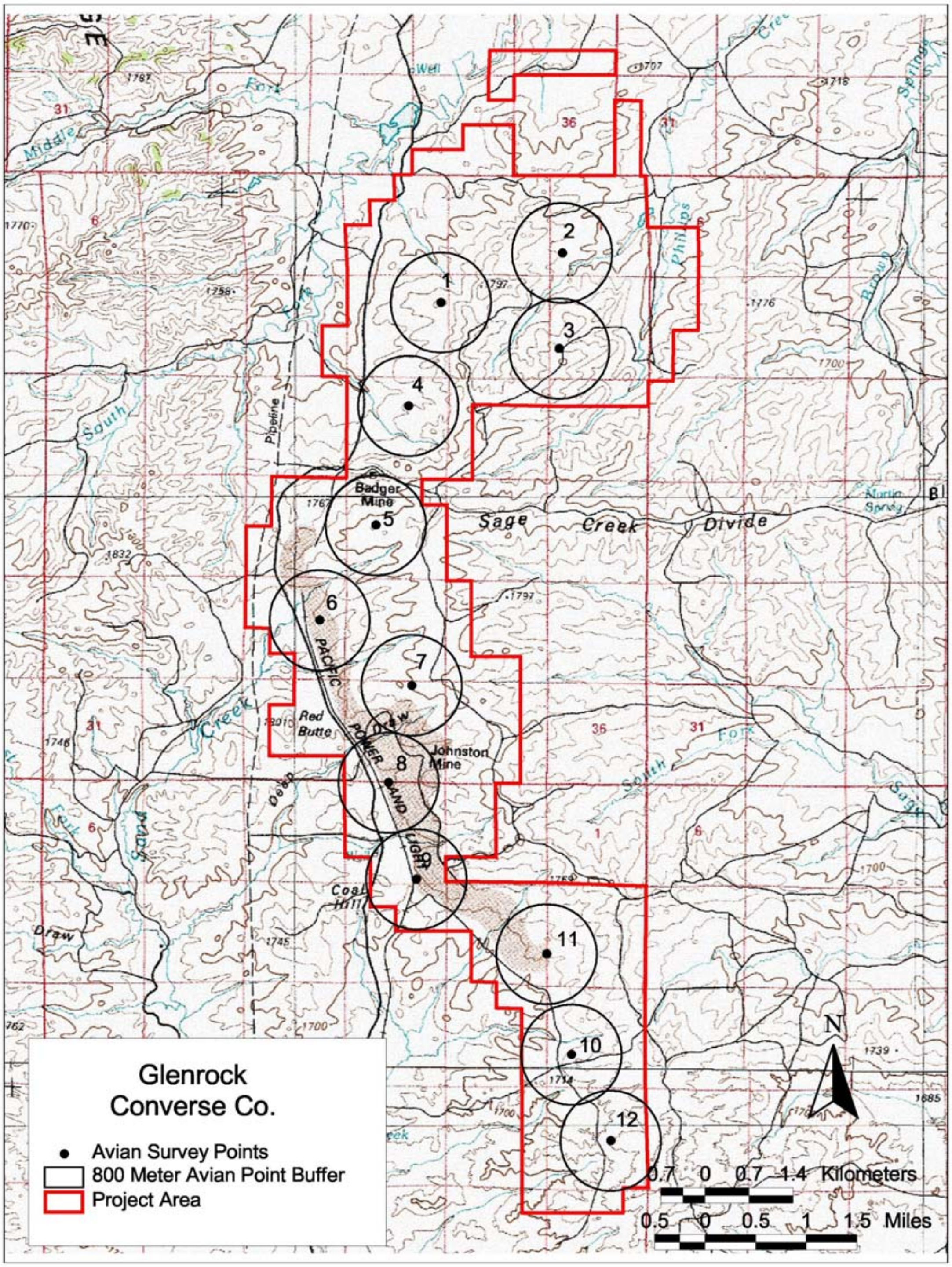


Figure 2. Fixed-point bird use survey points at the GWRA (April 18, 2007– November 14, 2007).

.

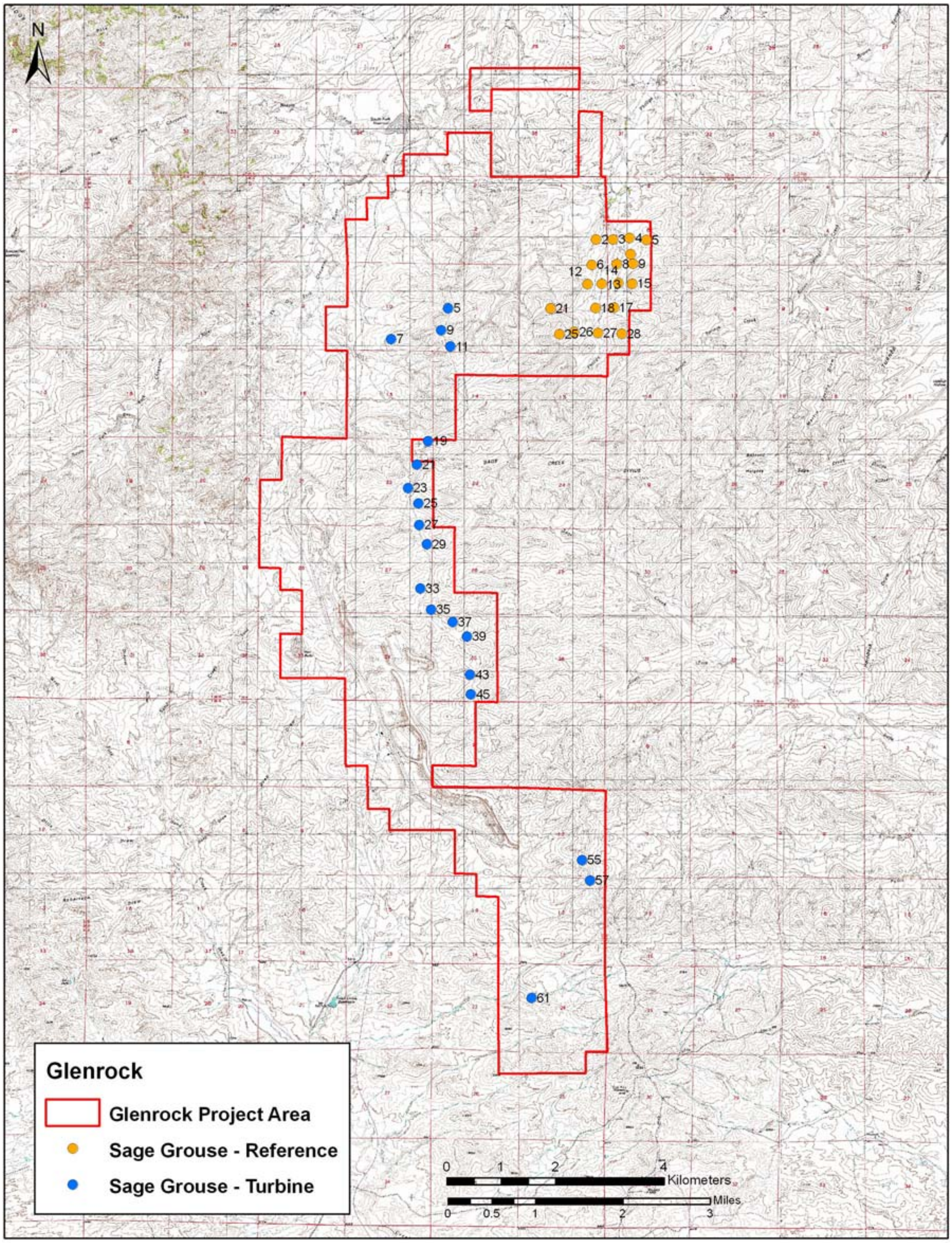


Figure 3. Location of greater sage-grouse pellet count turbine and reference plots at the GWRA

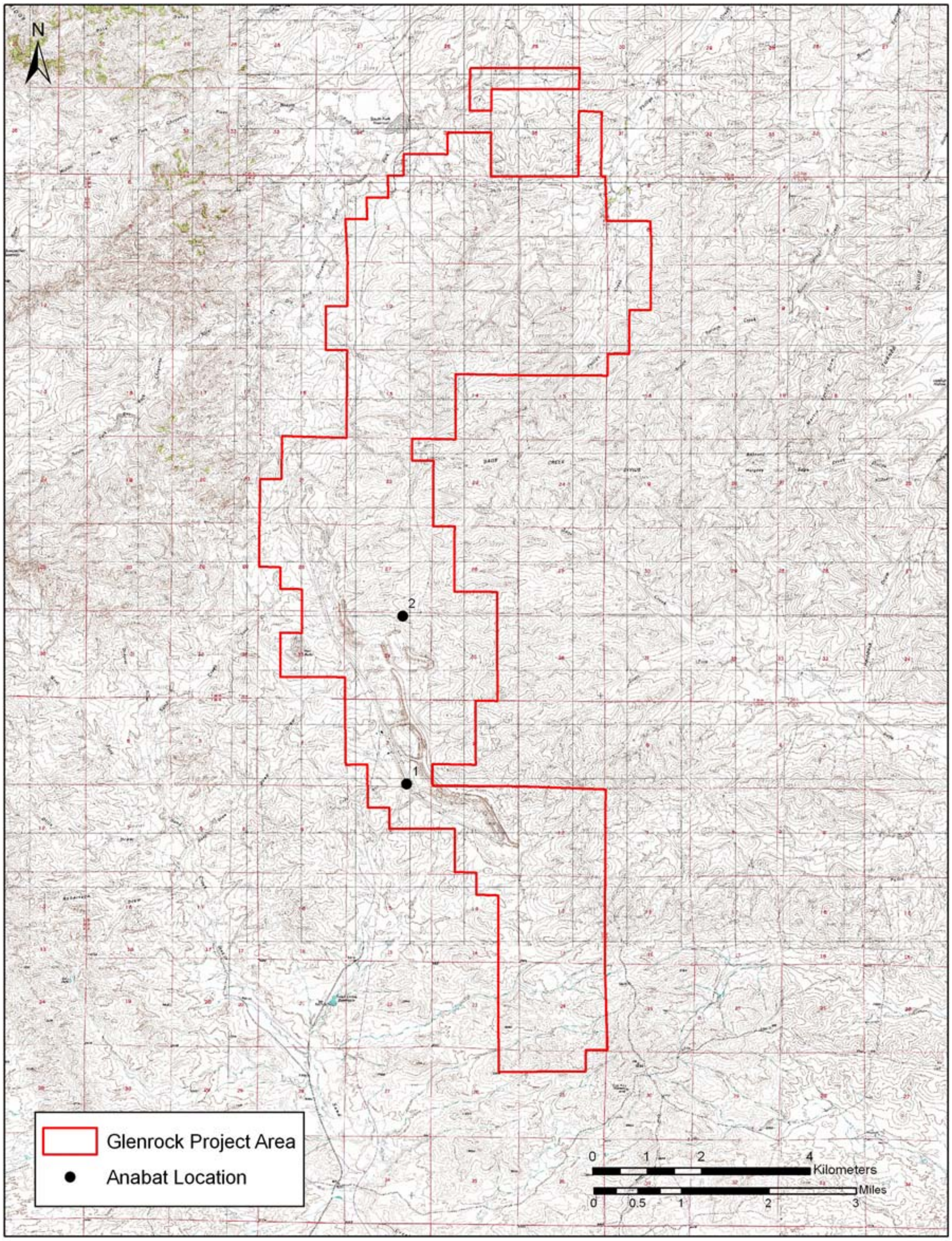


Figure 4. Anabat detector locations at the GWRA, August 3 to October 16, 2007.

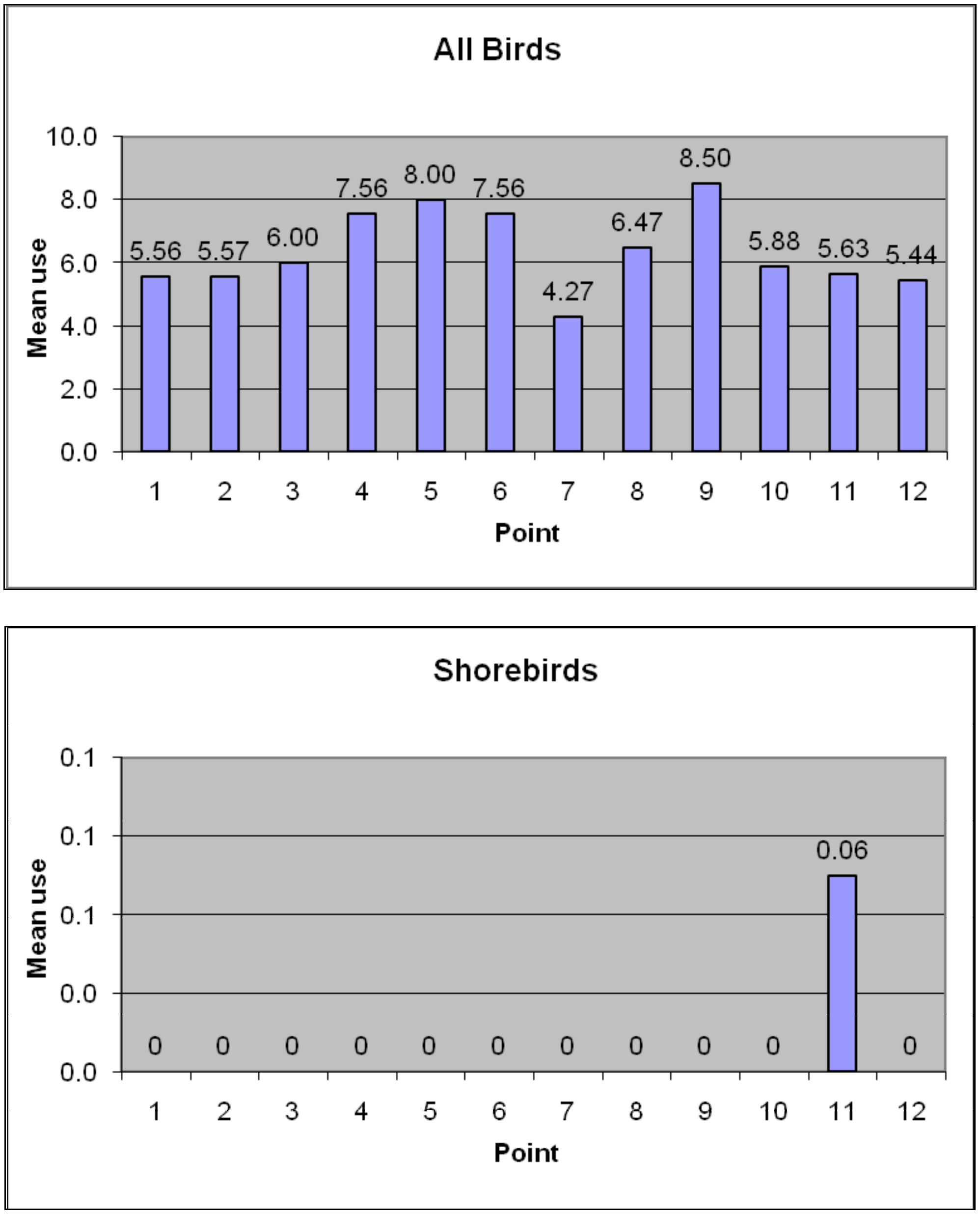
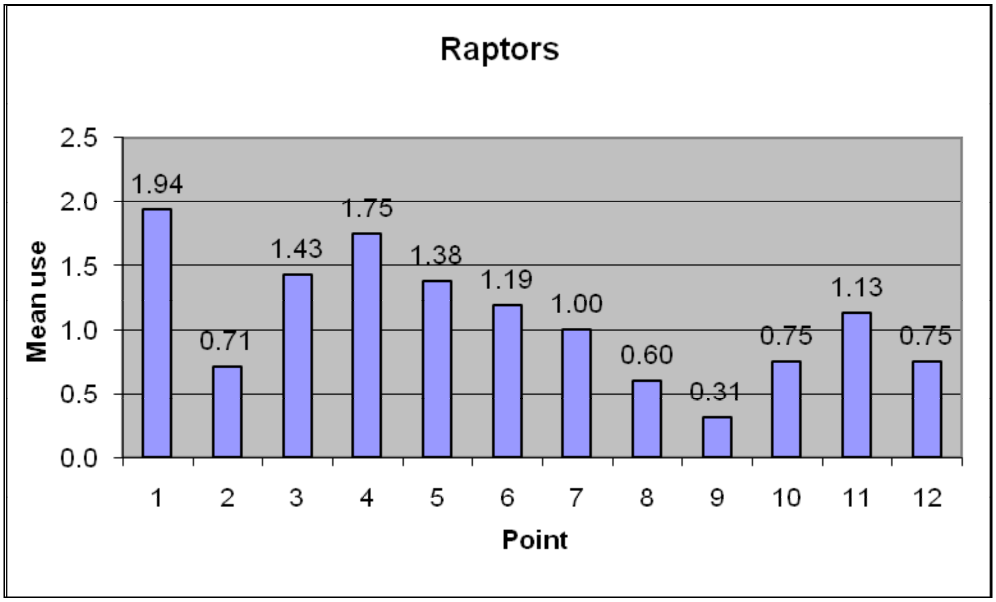


Figure 5a-b. Mean use (birds/30-minute survey) at each fixed-point bird use survey point for all birds, shorebirds, raptors, passerines, upland game birds, and doves/pigeons at the GWRA.



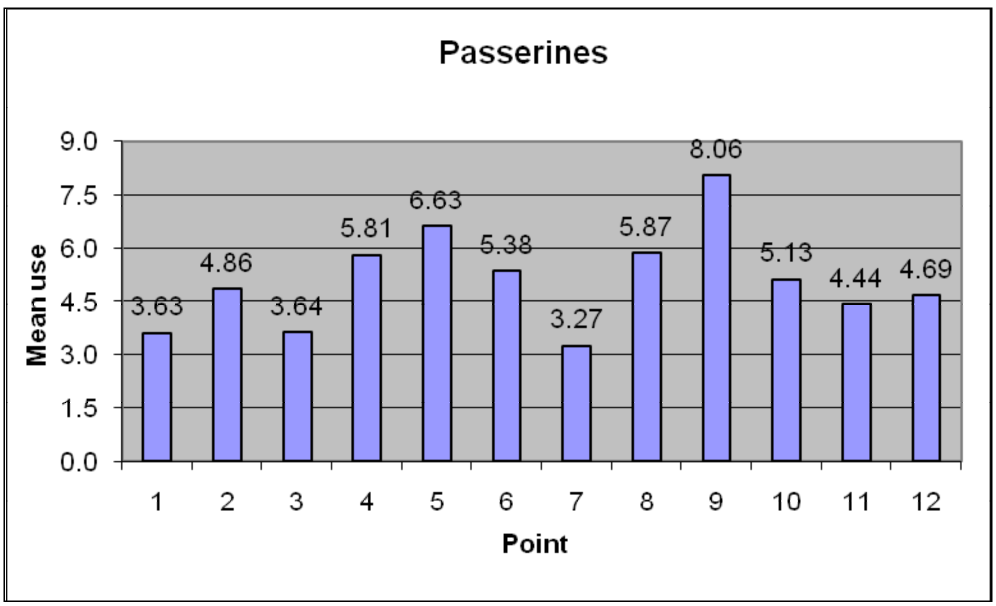
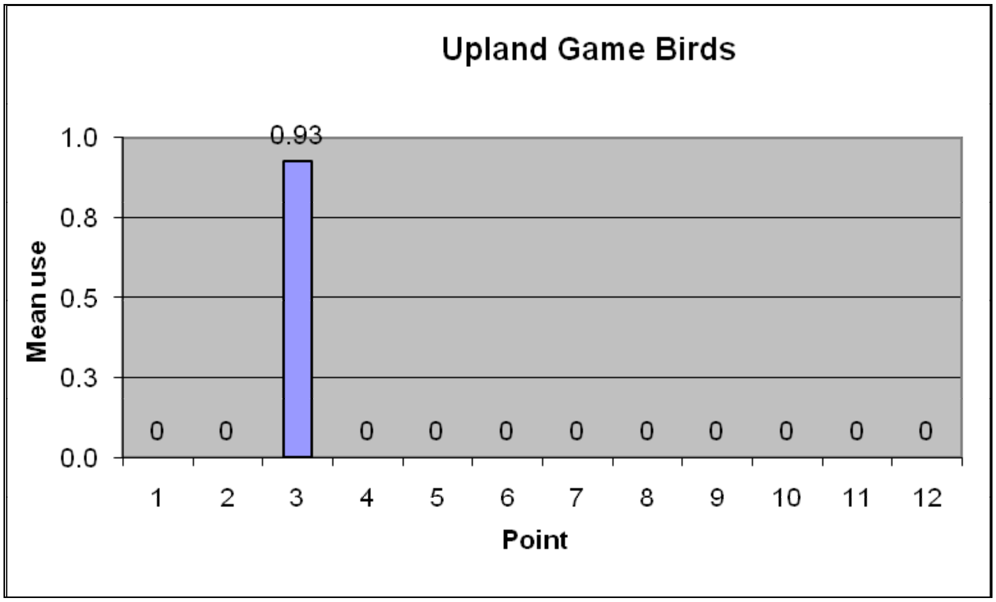


Figure 5c-d. Mean use (birds/30-minute survey) at each fixed-point bird use survey point for all birds, shorebirds, raptors, passerines, upland game birds, and doves/pigeons at the GWRA (continued).



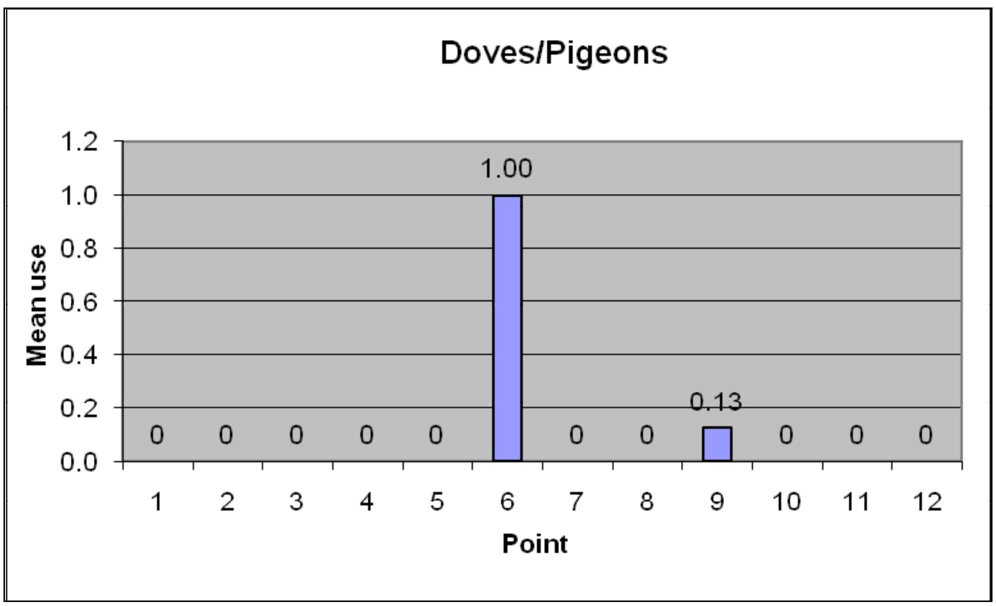


Figure 5e-f. Mean use (birds/30-minute survey) at each fixed-point bird use survey point for all birds, shorebirds, raptors, passerines, upland game birds, and doves/pigeons at the GWRA (continued).

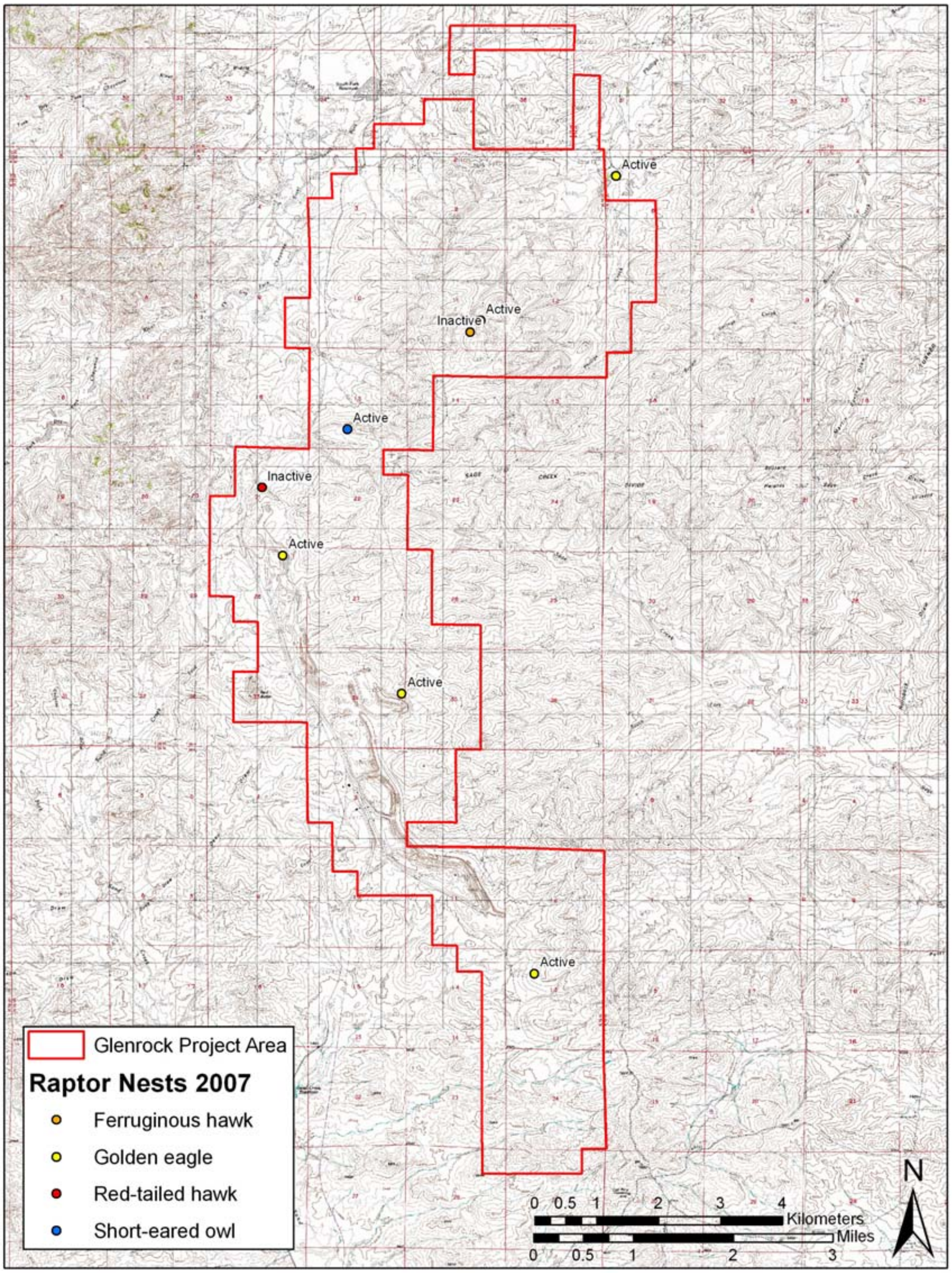


Figure 6. Raptor nests located during surveys at the GWRA, April 18, 2007– November 14, 2007.

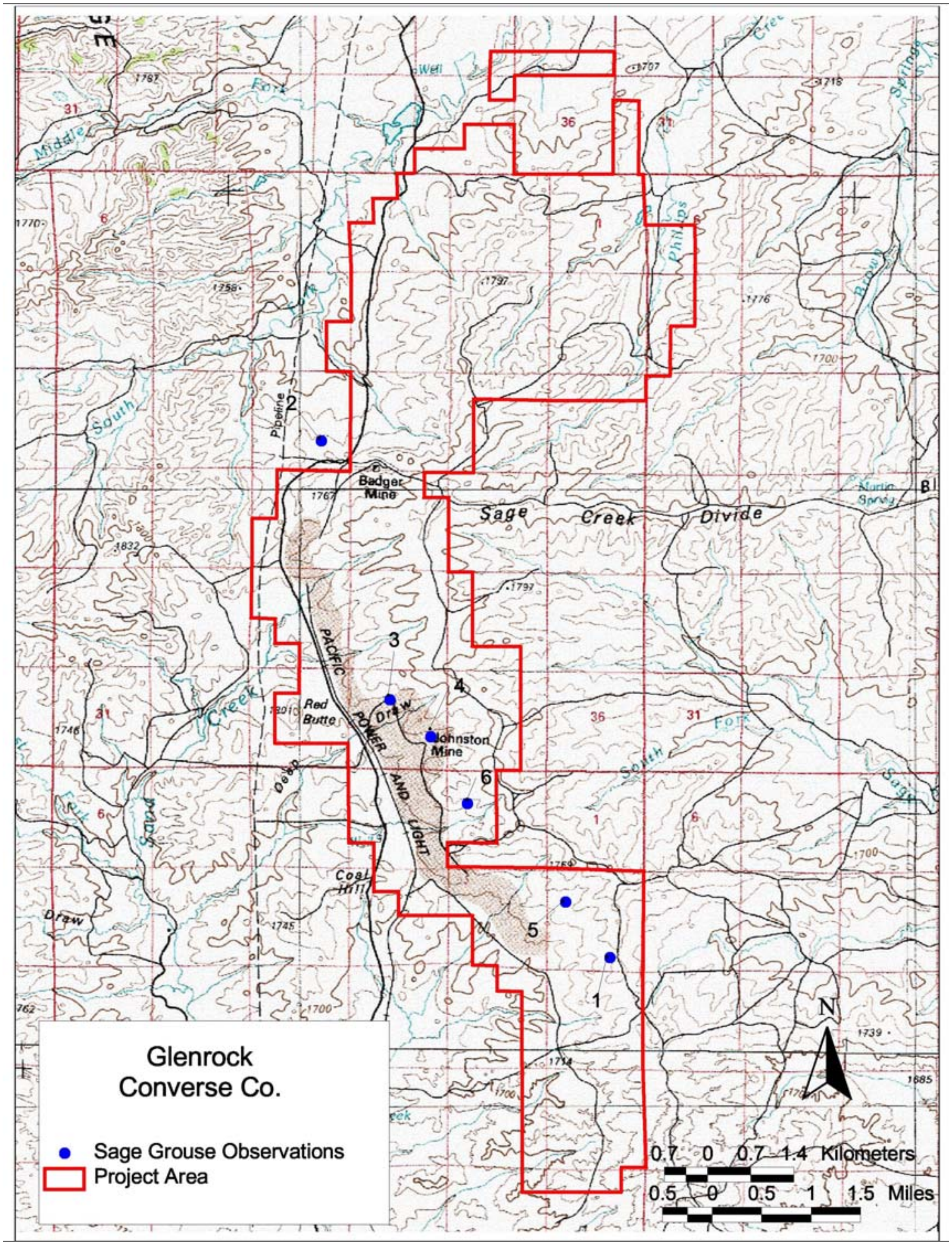
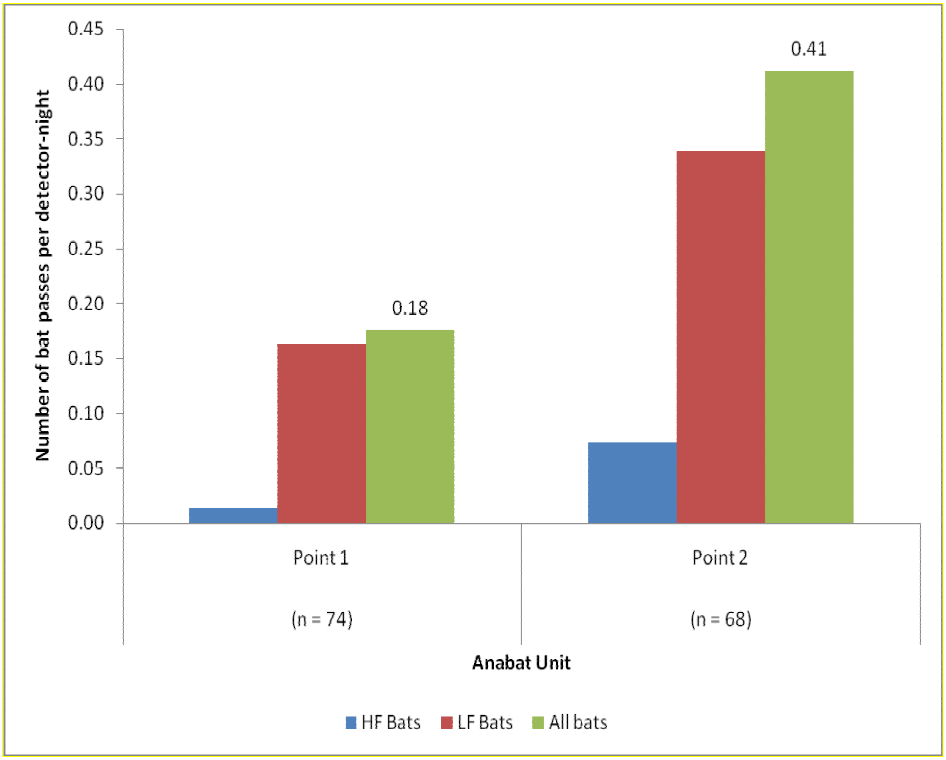


Figure 7. Location of sage-grouse observed in or near the GWRA.



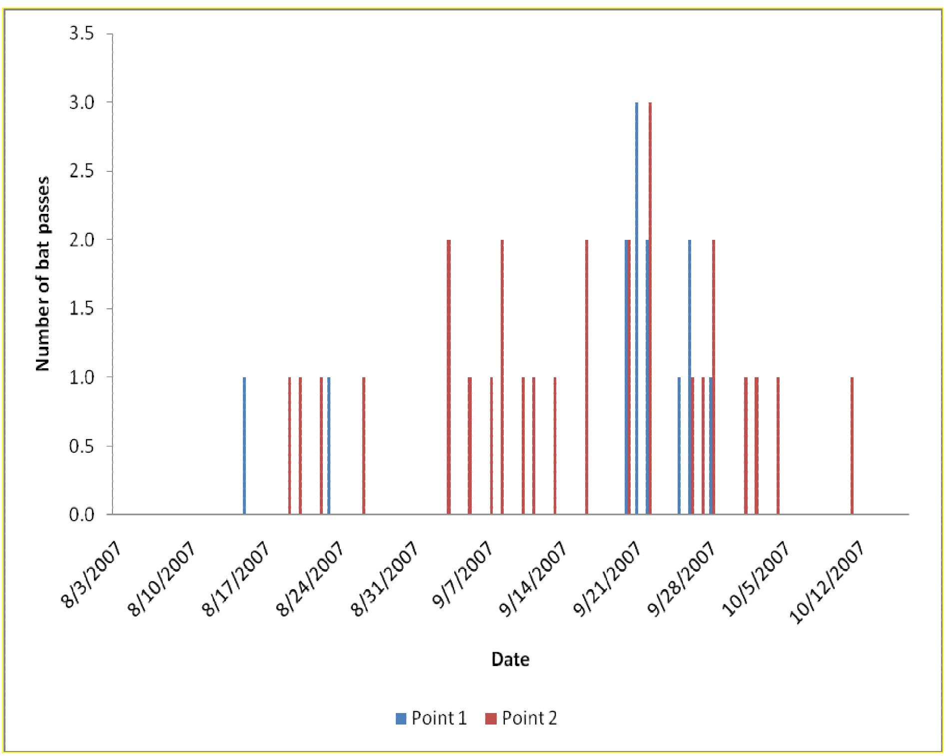


Figure 8a-b. (a) Number of bat passes per detector-night by location, and (b) number of nightly bat passes by location, at the proposed Glenrock Wind Project Area.

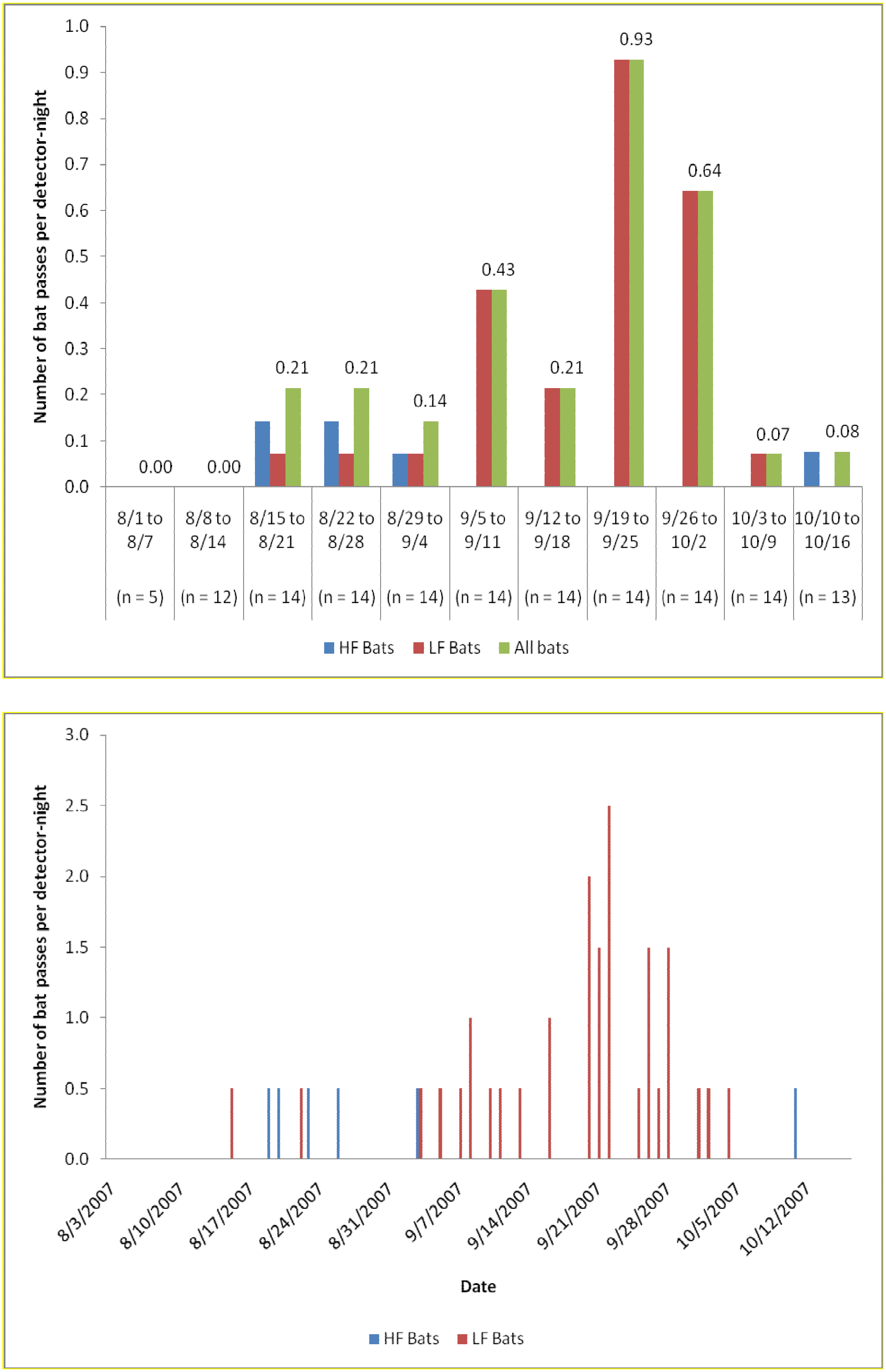


Figure 9a-b. (a) Weekly, and (b) nightly activity by high- and low-frequency bats at the proposed Glenrock Wind Resource Area.

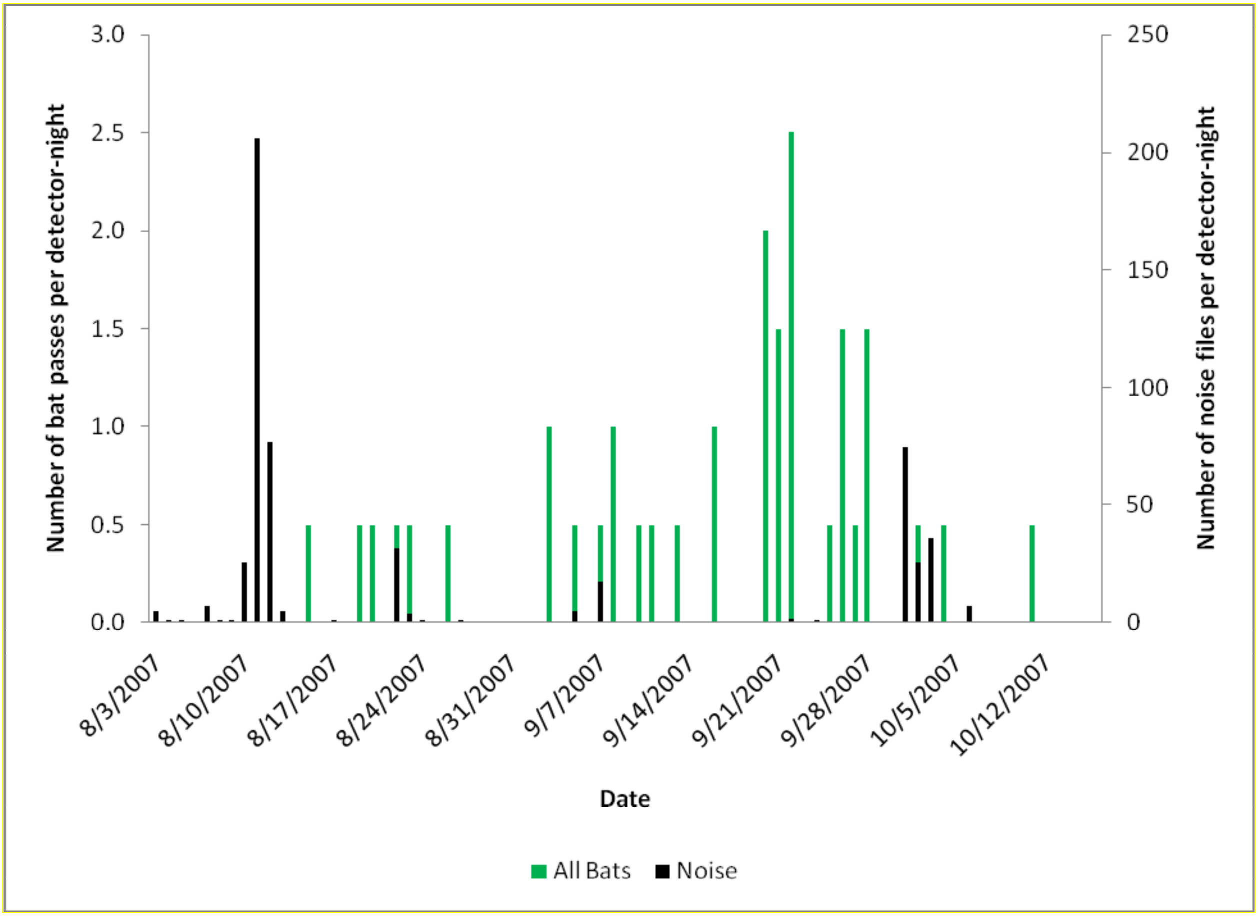


Figure 10. Number of bat passes and noise files detected per detector-night at the Glenrock Wind Resource Area, presented nightly.

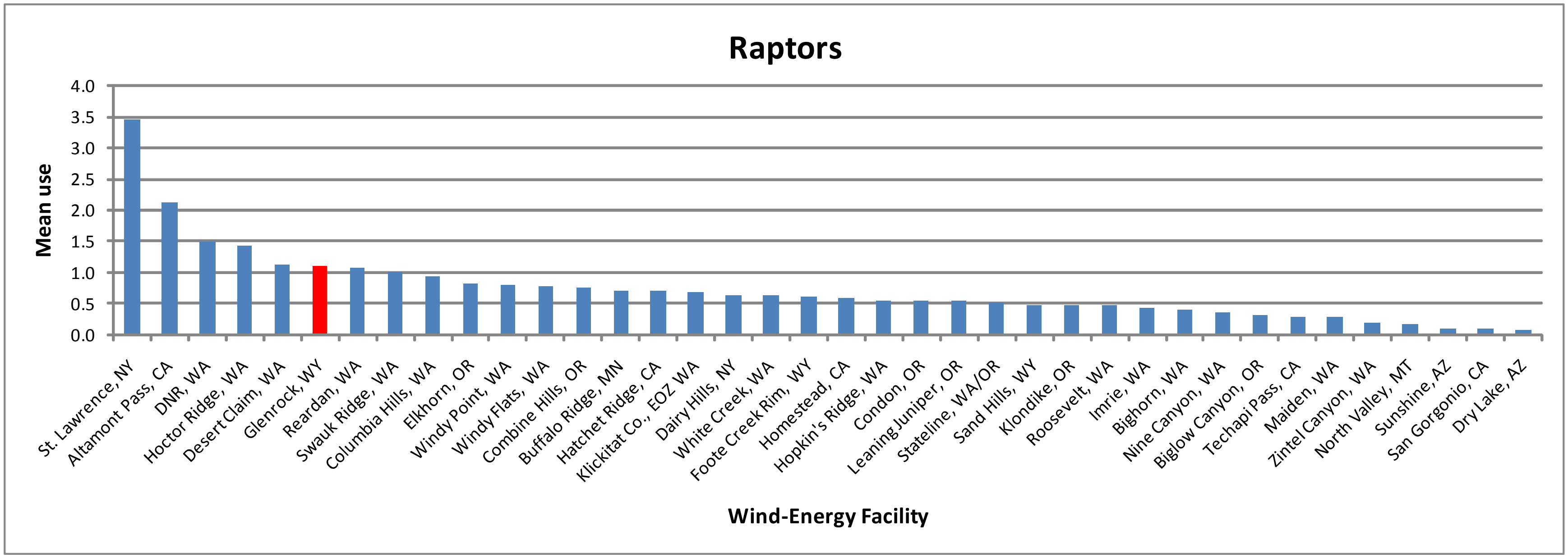


Figure 11. Comparison of raptor use in the spring between the GWRA and other US wind-energy facilities. *

* Data from the following sources:

Location	Source	Location	Source	Location	Source	Location	Source
Glenrock, WY	This study						
St. Lawrence, NY	Kerns et al. 2007	Windy Point, WA	Johnson et al. 2006a	Homestead, CA	WEST et al. 2007b	Bighorn, WA	Johnson et al. 2004a
Altamont Pass, CA	Erickson et al. 2002	Windy Flats, WA	Johnson et al. 2007	Hopkin's Ridge, WA	Young et al. 2003e	Nine Canyon, WA	Erickson et al. 2002
DNR, WA	Johnson et al. 2006c	Combine Hills, OR	Young et al. 2003b	Condon, OR	Erickson et al. 2002	Biglow Canyon, OR	WEST 2007a
Hoctor Ridge, WA	Johnson et al. 2006d	Buffalo Ridge, MN	Erickson et al. 2002	Leaning Juniper, OR	NWC and WEST 2005b	Techapi Pass, OR	Erickson et al. 2002
Desert Claim, WA	Young et al. 2003b	Hatchet Ridge, CA	Young et al. 2007a	Stateline, WA/OR	Erickson et al. 2002	Maiden, WA	Erickson et al. 2002
Reardon, WA	WEST 2005b	Klickitat Co., EOZ WA	WEST and NWC 2003a	Sand Hills, WY	Johnson et al. 2006b	Zintel Canyon, WA	Erickson et al. 2002
Swauk Ridge, WA	Erickson et al. 2003	Dairy Hills, NY	Young et al. 2006	Klondike, OR	Johnson et al. 2002	North Valley, MT	**
Columbia Hills, WA	Erickson et al. 2002	White Creek, WA	NWC and WEST 2005a	Roosevelt, WA	NWC and WEST 2004	Sunshine, AZ	WEST and CPRS 2006
Elkhorn, OR	WEST 2005a	Foote Creek Rim, WY	Erickson et al. 2002	Imrie, WA	Johnson et al. 2006e	San Gorginio, CA	Erickson et al. 2002
						Dry Lake, AZ	Young et al. 2007c

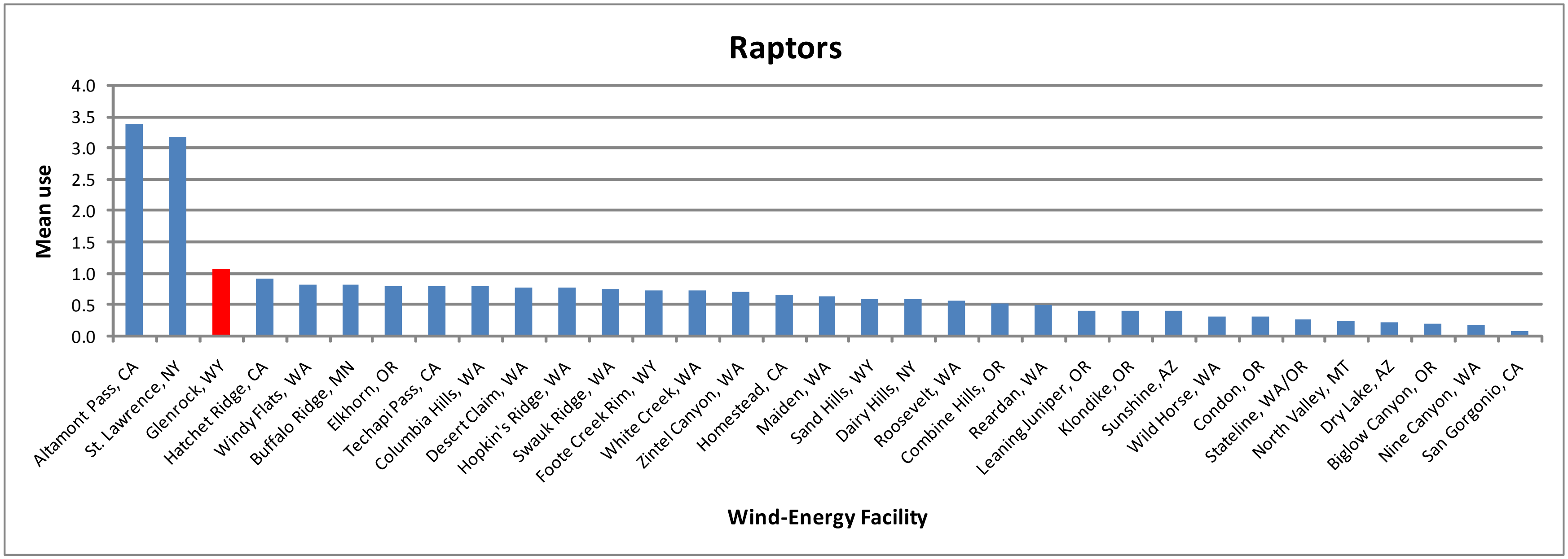


Figure 12. Comparison of raptor use in the fall between the GWRA and other US wind-energy facilities. *

* Data from the following sources:

Location	Source	Location	Source	Location	Source	Location	Source
Glenrock, WY	This study.						
Altamont Pass, CA	Erickson et al. 2002	Desert Claim, WA	Young et al. 2003c	Sand Hills, WY	Johnson et al. 2006b	Wild Horse, WA	Erickson et al. 2008
St. Lawrence, NY	Kerns et al. 2007	Hopkin's Ridge, CA	Young et al. 2007b	Dairy Hills, NY	Young et al. 2006	Condon, OR	Erickson et al. 2002
Hatchet Ridge, CA	Young et al. 2007a	Swauk Ridge, WA	Erickson et al. 2003b	Roosevelt, WA	NWC and WEST 2004	Stateline, WA/OR	Erickson et al. 2002
Windy Flats, WA	Johnson et al. 2007	Foote Creek Rim, WY	Erickson et al. 2002	Combine Hills, OR	Young et al. 2003b	North Valley, MT	**
Buffalo Ridge, MN	Erickson et al. 2002	White Creek, WA	NWC and WEST 2005a	Reardon, WA	WEST 2005b	Dry Lake, AZ	Young et al. 2007c
Elkhorn, OR	WEST 2005a	Zintel Canyon, WA	Erickson et al. 2002	Leaning Juniper, OR	NWC and WEST 2005b	Biglow Canyon, OR	WEST 2007a
Techapi Pass, CA	Erickson et al. 2002	Homestead, CA	WEST et al. 2007b	Klondike, OR	Johnson et al. 2002	Nine Canyon, WA	Erickson et al. 2002
Columbia Hills, WA	Erickson et al. 2002	Maiden, WA	Erickson et al. 2002	Sunshine, AZ	WEST and CPRS 2006	San Gorgonio, CA	Erickson et al. 2002

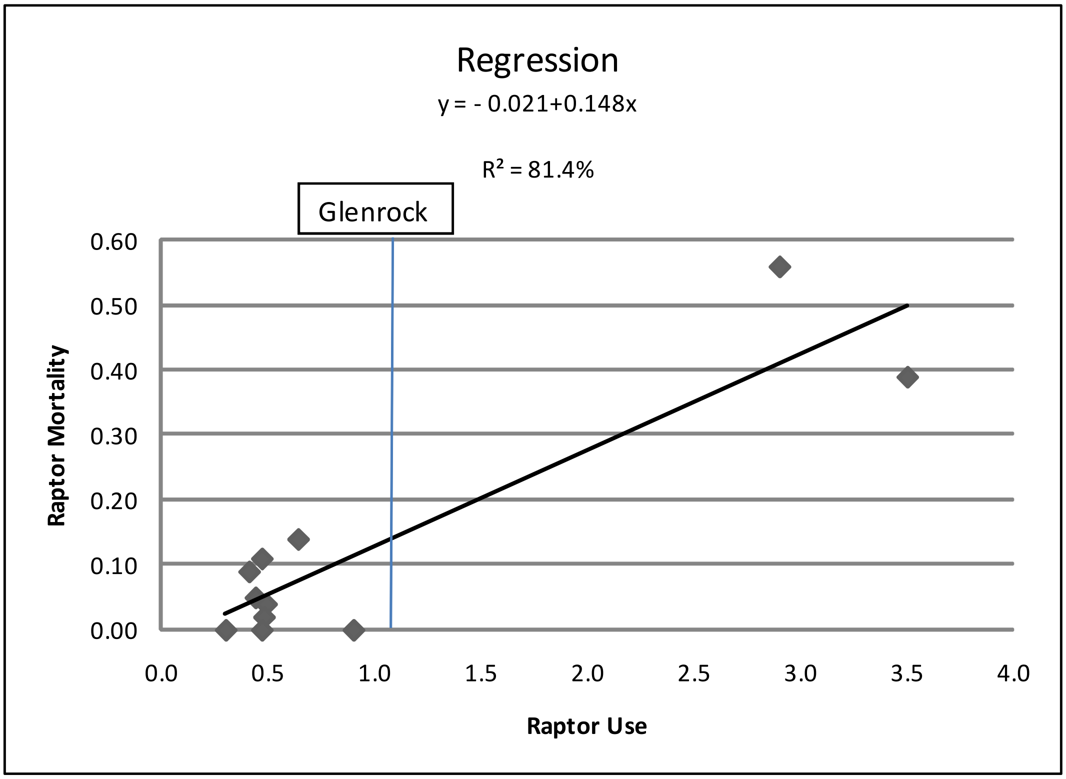


Figure 13. Regression analysis comparing raptor use estimations versus estimated raptor mortality.*

* Data from the following sources:

Raptor Use	Raptor Mortality	Wind-Energy Facility	Study
0.3	0	Vansycle, OR	Erickson et al. 2000
0.41	0.09	Stateline WA/OR	Erickson et al. 2002
0.44	0.05	Nine Canyon Phase I and II, WA	Erickson et al. 2002
0.47	0	Klondike, OR	Johnson et al. 2002
0.47	0.11	Klondike II, OR	NWC and WEST 2007
0.48	0.02	Buffalo Ridge, MN	Erickson et al. 2002
0.49	0.04	Foote Creek Rim, WY	Erickson et al. 2002
0.64	0.14	Hopkin's Ridge, WA	Young et al. 2007b
0.9	0	Combine Hills, OR	Young et al. 2003a
2.9	0.56	Diablo Winds, CA	WEST 2006
3.5	0.39	High Winds, CA	Kerlinger et al. 2005